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DR. LE PLONGEON'S LATEST AND MOST IMPORTANT DISCOVERIES AMONG THE RUINED CITIES OF YUCATAN.

THE accompanying engravings and descriptions formed the basis of several articles that appeared not long ago in the SCIENTIFIC AMERICAN. The great interest of the subject induces us to republish them all in one number of the SUPPLEMENT. The descriptive matter is from the pen of Alice D. Le Plongeon, the accomplished wife of the discoverer. All the dangers and privations of the Doctor in making these extraordinary explorations have been shared by this lady, whose vigor and courage were equal to every emergency.

Both Dr. Le Plongeon and his lady are superior photographers, and they have brought home hundreds of negatives of remarkable objects, and also many impressions, illustrating the history of the Maya race, the ancestors, as the Doctor shows, of the Egyptians. Our engravings are made by transfer of the photographs to the blocks without the interposition of the draughtsman's pencil.

FIG. 1.—INNER APARTMENT OF CHAACMOL'S MONUMENT, WITH STONE ALTAR SUPPORTED BY FIFTEEN CARYATIDES.

Mrs. Le Plongeon writes us as follows:

In 1875, when Dr. Le Plongeon brought to light the then beautiful statue that for good reasons he called Chaacmol (Leopard), people who knew nothing about it said that he had given that name at random, or for some fancy, which assertion was as foolish as it was unjust. As among us we have Mr. White, Mr. Black, Mr. Long, Mr. Short, Mr. Wolf, Mr. Fish, so the Mayas had for names animals and other objects, and when their portraits were made, instead of inscribing their name beneath, as we frequently do, they put a picture of the animal or object whose name they bore, above their head or on their breast, sometimes both. Thus we see a dignified looking gentleman, elegantly dressed and well armed, with a pretty goblet above his head; he is Mr. Cul, cul being the Maya word for cup. From certain

FIG. 2.—CARYATID IN MAUSOLEUM OF CHAACMOL, YUCATAN (FRONT).

FIG. 3.—CARYATID IN MAUSOLEUM OF CHAACMOL, YUCATAN (BACK).

indications of mural paintings and sculptures, Dr. Le Plongeon was led to look in one place for the statue of a man named Leopard, and when on reaching that he saw a monument with a sculptured leopard on the top, and slabs with leopards carved on them round it, his conviction was confirmed. He then unearthed the statue of Chaacmol; and it was to the memory of that warrior that the monument I propose to describe was raised. It consisted of two apartments, the outer, without any front wall, being more like a grand portico. The front half of the triangular arched roof rested on massive round stone pillars, with feathers carved on the front and sides, while on the other part the scales of the serpent's belly are represented. The base, formed of a monolith two meters long, one meter fifty centimeters wide, and one meter twenty-five centimeters high, resembles a serpent's head with open mouth, whose projecting tongue alone requires two strong men to move it. (See engraving.)

But the roof of this front room fell, burying beneath its debris the pillars and other beautiful objects between them. A thorough excavation brought to light a stone altar; the upper part, or table, consisted of two stones fifteen centimeters thick, that together were two meters ten centimeters square, or be it six feet ten inches. Most unhappily, the roof, in falling, broke the table into fragments; nevertheless, as the piece remained in place, it is not difficult to see that it was sculptured in bas-relief, representing two men, one seated, the other standing. The edge of the table is also exquisitely carved, showing priests in various postures, making offerings; of the parts least injured Dr. Le Plongeon made moulds. Smashed, even pulverized in some parts, by the enormous stones, weighing hundreds of pounds, that fell on it, the table yet served to protect fifteen figures that supported it as caryatides. These were placed three abreast, five deep, with their arms upraised. They are eighty-five centimeters high, fifty centimeters wide at the top, and thirty-five at the base. Except in their position, there are not two alike in any respect. The outermost ones have their noses broken, but those within are perfect as if just from the master's hand. They are very interesting and important, showing, as they do, the features, ornaments, and dresses of those people, for the artists paid little attention to the body, bestowing the utmost skill and care on the face, ornaments, and dress. The heads are well shaped, disproving again the assertion of some writers that the Mayas deformed their skulls. That custom was introduced by people who about 1,500 years ago invaded the country from the side of Bacalax, destroyed Chichen Itza, took possession of Uxmal, and in fact became masters of the country after destroying the dynasty of the Caes, as we read in an inscription carved on the facade of one of the principal monuments of Uxmal. These Toltecs, or Naualts, with their religious rites and other customs, introduced that of deforming the skull, a practice that was in vogue even among the Mayas at the time of the Spanish conquest, as Landa informs us. Very lately a skull has been unearthed in Progreso, the port of Yucatan, quite conoidal in form, being flattened back and front, and rising like a peak at the top.

All the caryatides have head dresses on which are chiseled with great delicacy various designs, some figuring mosaic work that those people used to ornament their dresses, made of bone, shell, ivory, and such substances, cut in various shapes, and painted with bright colors. Other headgears are covered with feathers, the lines exquisitely fine; and the back of each figure is sculptured to imitate a mantle of feathers, but in each the feathers are differently arranged. Their hair is cut short in front and combed straight, to come partly over the forehead; thus we see that it is a very old fashion to *bang* the hair. The eyes are two-thirds natural size; some are decidedly feminine, and their dress seems to be that of women. The eyes are open, foreheads broad, noses correct in shape according to our present ideas of beauty, some quite small and fine; lips thin and firm. Some have the upper row of teeth visible, and they are small and even, not filed like a saw, so that fashion was evidently not compulsory, though some followed it, as we learn from the Chaacmol statue and others. All have ornaments in their noses, and some of them consist of two small disks, linked by a tiny straight bar. It is very possible that these links were made of some metallic substance. Besides the ornaments fastened on the nostrils, several have one hanging from the cartilage, down over the lips. As well as disfiguring a pretty face, it must have been most uncomfortable, and shows that people in those times made themselves the foolish slaves of fashion, just as now. One face is so covered that the features can hardly be seen; two serpent heads face each other on the forehead, and their bodies encircle the eyes; other snake bodies surround the mouth, the heads resting on the cheeks.

It is not easy for the pen to give an exact idea of how these caryatides are formed. The bodies do not correspond to the size of the faces, yet the feet are large, to serve as a firm base for the table they supported. From the knees up to the throat there is very little form, and though we see that the arms are upraised, the hands are not defined, but lose themselves in the flat part of the stone that is above the head, and on which the table rested. As far back as where the ears should be, the faces are completely in the round, but from there the stone extends on each side, and on that stone, in the place where ears should be, are large circular ornaments. One figure has square tablets instead, and on them a finely chased inscription that causes us to exclaim: "They must have had metal to work with!" The large circular ornaments have for center the face of an old man, but not all alike; so they may have been portraits of individuals celebrated among them.

The toe nails of these figures have fallen out; for the Maya artists made nails and eyes of shell for their statues, which were also painted in vivid colors. The feet are shod with sandals, each fastened with a different bow, knot, or clasp. From their necks are suspended badges, necklaces, and other ornaments. One has an animal carved on the badge. Some have handsome waist belts, and three cornered aprons, trimmed in divers manners, especially with flat plaiting.

As so little care has been given to the body, it is not easy to decide upon the shape of the garments, but some certainly have a short tunic folded round their hips, closing in front by one end lapping over the other, the corners being curved from waist to bottom of garment.

We have reason to suppose that these figures were likenesses of individuals attached to the warrior Coh, and they supported the altar on which offerings were made to the manes of that chieftain. The room beyond the altar seems to have been a funereal chamber. The concrete floor was painted red; in spots the color is still bright. Opposite the doorway there is an *estrade*, half the width of the room, which is narrow, and two or three yards long. The walls are perpendicular to a height of three meters, then slant inward, forming a triangular arch, the total height of the room being about six meters. Throughout the ruins the same shaped roof is used, in some cases without any capping stone. The room has its walls covered with paintings, from floor to apex of roof. Red, blue, green, and yellow are the colors that form the pictures, but the outlines are drawn with a dark brown paint (bister); another color is also used, that I may, perhaps, call maroon, to paint boats and other objects that represent wood, for among the paintings are large boats; in one of them people painted blue are fighting with others painted yellowish-brown, and these last are apparently quite overcome by the men painted blue. Our future studies will doubtless give us a clew to all this.

"What! did M. Charnay do that?" "No, it was M. the *Consul Americano*, who accompanied M. Charnay." We left the wall as we found it; it was no longer in a condition to be copied.

The jambs of the door of this funereal chamber, and the square pillars that are against them, forming, as it were, a triple jamb, are covered all over, on every side, with warriors dressed and armed. The work is perfect, and painted in bright colors. The figures are nearly life-size, and Dr. Le Plongeon has made moulds of all, they being important to show the various types, dresses, insignia, and weapons. The faces, whether sculptured or painted, are in profile, not

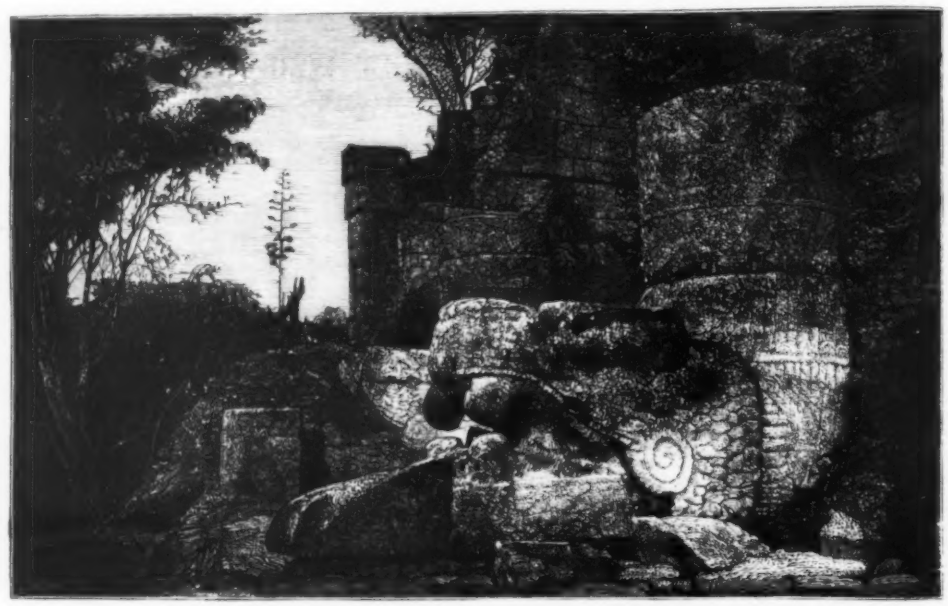


FIG. 4.—THE MONUMENT OF CHAACMOL, AT CHICHEN ITZA, YUCATAN.

The mural paintings upon the walls of the inner room of the Mausoleum of Chaacmol are separated into tableaus divided by horizontal lines. Each figure is about nine inches high, and as we have many reasons for supposing that these people were about our own size, perhaps a little bigger, we may say that the artist allowed one and a half inches for each foot. The outlines are bold, decided, and graceful, but the tints are flat, and the perspective was evidently not understood by those artists, except in a very limited manner. Nevertheless, as these are the only actual mural paintings that we have found during a ten years' study in the ruined cities of ancient Yucatan, we consider them of remarkable interest and value, being the last remnants of the art of painting (mural) among the Mayas. Religious ceremonies, battles, and domestic scenes, as well as grand processions, are depicted on that wall—a fading gem of antique art.

In 1875, Dr. Le Plongeon made tracings on transparent paper of the best preserved tableaus, and from these tracings a facsimile of those portions of the wall was made and lent to the Metropolitan Museum of Art, Central Park, N. Y., where they are now on exhibition. At the time we made these tracings (1875) one part of the precious wall was covered with the dirt of centuries; for, alas! these palaces are

FIG. 5.—SCULPTURED STONE WORK.

now the abodes of bats and swallows, that build their nests in small, square holes on the sides of the roofed arch—holes that supported the ends of wooden beams of choicest wood, polished, and sometimes carved. We had not then with us the means of cleaning those paintings, but now (1884) came prepared to cleanse and copy all that could possibly be saved. To our grief, we at once saw that some one had tried to clean the wall by *scratching* off the dirt. In answer to our exclamations of disgust, some of the soldiers that escorted us in our expedition said: "Oh, yes! that gentleman who came two years ago did it; he scraped it with a machete, and said: 'Look at this ugly little old woman!'" We said: because the Maya artists did not know how to make a full face, for the sculptures in the round prove to the contrary, but because they preferred it; just as they did the triangular arch to the round, which they knew well enough how to make, for on the very wall just mentioned domed buildings are painted. I must also say that the aborigines are generally better looking side face than full face, and they must have been well aware of the fact; even though the beautiful Maya women, say the historians, did not use a looking glass to see what position best suited their face; only the men indulged in that vanity.

The most interesting remains of the art of sculpture among the Mayas are the *sapote* beams that form the lintel of the funereal chamber. Unhappily, the carving of that lintel has been much defaced by individuals who have hacked it with machetes. What remains shows how exquisitely those Mayas could carve wood in most intricate designs.

Dr. Le Plongeon has made moulds of the lintel, as much for the historical teaching it conveys as because it is the last specimen of wood carving among the ancient Mayas. On examining the closeness and depth of the lines, we find it hard to believe that the artist had no finer tools than those of obsidian or silex; the intaglios are nearly three-fourths of an inch deep, and *sapote* is very hard wood. In making the mould of these carvings Dr. Le Plongeon discovered that the surface of the wood was covered with a thick coating of a yellowish gummy substance, that when rubbed with a wet brush yielded a thick, froth-like soap, which led us to suppose that the substance, whatever it may be, was used by the artist to preserve the wood from insects and protect it from atmospheric influence.

THE STATUE OF CHAACMOL.

In the year 1875, when we unearthed the statue called

Chaacmol, now in the museum at the capital of Mexico, Dr. Le Plongeon discovered a monument that he considered of great importance, and, returning here, he decided to examine the interior. He succeeded in measuring the original dimensions, though it was reduced to little more than a shapeless pile of stones, with broken stairs on one side, and

FIG. 6.—SHOWING HOW THE EXCAVATIONS WERE MADE.

covered with bush. The structure was square, its four sides faced the cardinal points, and on each were thirteen stairs, three meters eighty centimeters wide, that led to the top platform, exactly four meters above the ground, and sixteen meters square. In the center was a large stone slab, on which formerly was a statue of a man about double life-size, in a reclining posture, like the statue Chaacmol.

The fragments of this gigantic statue are scattered at the base of the mound, only the lower limbs being entire, which show us the position it had. On the sides of the monument, in the spaces between the stairs, there were finely sculptured stones.

Only a few are now in place, and Dr. Le Plongeon has made photos and moulds of them. The largest is one meter twenty-five centimeters high, and one meter thirty-five centimeters wide. It is a human face within the distended jaws of a snake, and on the sides of the face are Egyptian letters that give the name Cay Canchi. (See Fig. 5.)

On the north side of the mound, in a part where there was neither sculpture, stones, nor stairs, we set our men to open a trench one and a half meters wide, to reach the center of the mound, the interior of which consisted of unhewn stones, piled one over another, and mortar that seemed to have been poured among them. As the work proceeded, the sides had to be propped with a strong palisade made of tree trunks cut from the surrounding bush, to prevent the loose stones from falling on the laborers. (See Fig. 6.)

On the eighth day of the work, while Dr. Le Plongeon was making moulds in a grand castle, not very distant from the spot where he discovered the stone work just mentioned, he suddenly heard much shouting, and soon a man arrived, breathless with excitement, to tell him that they had "found a queen"! Arriving at the spot (see Fig. 7) we saw a figure on its back, about one and a half meters north from the center of the monument, and exactly on a level with the surface of the earth. The figure was thickly coated with

FIG. 7.—DISCOVERY OF A STATUE.

loose mortar. One leg was broken off below the knee, but we found it under the figure, and afterward adjusted it in place to make a picture. The head of the statue rested on a stone painted bright red, that represents the tongue of a serpent, the peculiar shape of which Dr. Le Plongeon long ago discovered to be the letter *chi* or *ch* of the Maya alphabet.

When the figure was placed upright we hardly knew what to call it, it appears so human, yet so apish. In the position it occupies it is ninety-seven centimeters (about three feet) high; so if standing would represent a very tall person. It is made of white limestone, and painted dark brown. The head is flat at the top and back, and apparently hairless, but painted blue, and over that are red streaks from the forehead down to the shoulders. The eyes are open, and painted blue around the lids. The nose is not pierced, but the clumsily made ears have each a large hole. The mouth is closed, and lips painted red. On the back part of the top of

FIG. 8.—THE STATUE AS IT APPEARED WHEN SET UP.

the head a hole is pierced, so that a string can be passed through, perhaps to secure a bunch of plumes, perhaps to keep a banner in place, for in the palm of the right hand there is a groove, as if for a round stick to fit in. The hands are not altogether human; where the fingers begin there seem to be mittens, the other ends of which are nowhere visible. (See Fig. 8.) The fingers, like the toes, were furnished with nails made of shell, and fitted in place with mortar, so as to look very natural, even in color. Unhappily, nearly all were fallen, but we found some of them. A necklace is indicated by a line of red paint around the throat. Garters, below the knee, are painted blue and red. The loins are covered with an ornamented *uiil*, a scanty garment yet in use among the aborigines, and anciently worn by Egyptian laborers. The right foot is turned in, as if the individual had been club-footed. The sandals are painted blue, and close up round the heel, but the very elaborate and fanciful fastenings are red. On one heel is the name Cay Canchi, written with red paint. This image may possibly represent the sacred monkey of the Mayas, as the Cynocephalus was emblematic of the god Thoth among the Egyptians.

On the facade of a very grand and extensive edifice at Chichen we see, close to a written and illustrated account of the creation, a figure exactly resembling the Cynocephalus of the Egyptians. We have also found it in Izamal and Usemah, both kneeling and sitting, and it was doubtless a much venerated object among the Mayas.

The stones and mortar having been cleared away, it was found that the statue had rested on conoidal stone pillars, placed horizontally side by side. Some were painted blue, others red, one meter high, and thirty centimeters in their thickest diameter; blue, by the bye, was the color of mourning among the Mayas, and was also a color much used at Egyptian funerals in ancient times, according to Sir Gardner Wilkinson.

The pillars on which the statue rested were not the only ones; they extended over a space of about eight square meters, and in some places were three and four deep, the total number being 182, half the number of the days in our year, less half a day. Two-thirds of the pillars are painted blue, and one-third red; they vary in height from eighty centimeters to one meter twenty-five centimeters. On a level with the pillars were twelve serpent heads, with feathers and many designs exquisitely sculptured all over them. (See Fig. 9.) Two large ones, and two small, looked toward the east, northeast, and southeast. Three on the west side of the excavation looked west, and three on the south looked south, and two others southeast. From the top of each head rises a kind of plume or perhaps flame, and on

each side of the front of the head perpendicular ornaments like horns, that we have discovered represent the opening pod of the *Ceiba* tree, sacred to the Mayas. Their ideal heaven was to rest beneath the shade of the *Yaxche* (*Ceiba*), eating sweet things, and enjoying the happy do-nothing. The opening pod of the tree, with the silky filament coming forth, served as models for the scepters and badges of authority seen in the hands of the chiefs whose stone likenesses adorn the buildings.

seem to be enamel, painted red and green, and cut in various shapes, having served to form mosaic work.

The ball of white glass is very interesting, proving that those people were acquainted with glass, and probably knew how to make it. At the time of the Spanish conquest looking glasses were in use among the Mayas, for the historians inform us that *only the men used them*. When the glass ball was taken from the urn, the Indian workmen said: "Holo! zazteen!" ("Here, the transparent stone.")

FIG. 9.—DISCOVERY OF TWELVE SERPENTS' HEADS

The feathers carved all over the upper part of the body of the stone serpents are painted green; the scales of the belly, well defined, are yellow, as also the edge of the jaws. The inside of the mouth and forked, projecting tongue are red, like the gums, though the teeth and fangs are white. Blue paint is round the eyes and over the brow. The whites of the eyes were made of shell, that had a round hole where the pupil should be. Perhaps the pupils were made of some brilliant stones that were removed when the stones were interred, for nothing that might have served such purpose has come to light. The horn-like ornaments on the front of the head are painted green and tipped with red, which is the color of the feather on the top. The largest head measures fifty centimeters in length, thirty-five from top to lower jaw, and twenty-five across the top. Unhappily, we found nearly all of them more or less broken; they are of soft limestone, but we also found the pieces, so they could be mended; they were undoubtedly broken at the time of making the mausoleum.

On the south side of the excavation, at the feet of the statue, but lower down, was a round, white stone urn that measures outside eighty centimeters in diameter and seventy in depth, with the lid that is seventeen centimeters thick. The diameter of the interior is fifty-five centimeters, and the depth twenty eight. (See Fig. 10.) With difficulty four men were able to slide off the lid. Then, at first sight, the urn seemed empty, except a little red earth in the bottom, but feeling among it, we found a trapezoidal piece of green jade, six centimeters long, four wide, and one centimeter thick. The jade stone was held in great esteem by the Mayas, as it is to-day by the Japanese. On one side of the piece found in the urn there is a human face—full face—and letters round it; it is well carved and highly polished. (See Fig. 11.) Besides this, we found in the urn a tube-shaped jade ornament, nearly three inches long, one end of which broke to pieces when we touched it. Also two pieces of the same stone, that look like halves of pierced ornaments, and a ball of white glass nearly an inch in diameter. We took all the dust that was in the urn, and with some trouble separated from it many small pieces of shell or bone, and some

Effectively, even to-day, there are people among the Indians of Yucatan who call themselves *H-men* (*m*) and *X-men* (*f*). The letter *H* before the word *men* is a contraction of the masculine article *Ah*, and the *X* a contraction of the feminine article *Ix*, which is pronounced ish; and as the *i* in Maya is like the English *e*, it is the feminine article *she* reversed. The *H-men* and *X-men* (wise men and women) use stones like the glass ball found, and in them pretend to see hidden things and coming events; so we may presume that clairvoyance was known among the Mayas; and Bishop Landa, in his work on Yucatan, tells us that soothsayers, who pretend to read futurity, formed part of the priesthood.

FIG 11.—CARVED JADE.

FIG. 10.—THE SERPENTS' HEADS AND ROUND URN.

After the serpent heads and urn were removed from the mound, with all the loose mortar and stones, we stand on a level floor, sixty centimeters below which was a small pile of bones, with one smoke-colored obsidian arrow-head, twelve centimeters long, on each side of it. Also fragments of fine pottery, some painted blue inside, the others with vestiges of a design in white.

Though the bones had been completely protected from the air, they were so rotten that we had to handle them with care for them not to fall to dust. They seem to have belonged to a small animal with long and pointed jaws and very pointed teeth. We wrapped each bone in a separate paper, so that later some qualified person might examine them.

Forty centimeters below these bones and arrowheads was a concrete floor beautifully leveled and painted bright red, which extended throughout the mound. Below this floor were loose stones without mortar to a depth of forty centimeters, then another floor painted yellow, making the seventh floor from the summit, though the upper floors were not polished like those beneath. Under the seventh floor there were more loose stones, sixty centimeters deep, then solid rock and Mother Earth. We next had the men to open further into the west or rather southwest part of the mound, in which direction the arrowheads had pointed, and after three days reached a very solid block of masonry. Within it, about a meter and a half west of the center of the mound, was a stone seventy-five centimeters long and sixty-five wide, standing upright, its surface facing east.

The stone is deeply carved with signs that had their meaning among the Maya priesthood, and painted blue, yellow, red, and green. Further south, two other similar stones were found face downward, on the red concrete floor; they were stood up, together, and a photograph made of them. There, also, was another stone with a fish sculptured on it, the fish being surrounded by a fold of a serpent's body.

No other object was found in this mausoleum, that seems to have been erected to the memory of a certain priest or wise man, called Cay Canchi, and also to conceal the remnants of some sacred temple that may have been destroyed by a great cataclysm; in which case we may presume that the apish figure was a principal and much respected object in that temple, and the property of the pontiff, since he inscribed his name (Cay Canchi) on the heel of the sandal; for we are not very ready to admit that the figure found is a likeness of a sage and philosopher—a learned man of the highest class, a nobleman among the Mayas.

The great statue that was thrown from the top of the mound and broken may have been a picture of Cay Canchi; we cannot now tell; but no image of him was within the mound. We have found an exquisite stone bust of that individual in Uxmal, but have left it concealed where found, because in Mexico no one would know how to appreciate it, and we are not allowed to carry any stone from the country out of Mexico. Even though we give them being by bringing them to light from the bowels of Mother Earth, we cannot call them ours, neither will the government pay us one cent for our discoveries, that is well able to make its museums the richest, *in American antiquities*, that exist in any country; but it seized the statue of Chaacmol, and refused to defray the expenses incurred in the discovery. Even the Congress at Washington refused to aid Dr. Le Plongeon in the recovery of his expenses, when Hon. George Hoar appealed for protection to the Senate in a paper marked "*Confidential*. 45th Congress, 2d session. Executive B. May 7, 1878." It seems that in America people who dedicate themselves to science, unless happy enough to be rich, run a good chance of starving, so far as the governments are concerned.

GENERAL OBSERVATIONS.

With abundant reason the Spanish soldiers and priests were amazed at the magnificent white stone houses which they saw on their arrival at Yucatan, in the fifteenth century. They little thought to find such edifices among people whom they regarded as savages, but who, in fact, were most civil, and so warlike and determined that they resisted the invaders for twenty years. True it is that at that time the inhabitants of the peninsula were a degenerate people, owing to the admixture of races which resulted from the invasion of nations inferior to the Mayas. Nevertheless, Spanish writers who had every opportunity for knowing tell us that the Europeans found the country thickly populated by most polite people, who enjoyed and appreciated the refinements of life; people who had current coin, though not metallic; who had just laws and upright judges; who considered it an unpardonable offense to lie; who were so honest that no document was needed to make a contract binding, nor doors to keep intruders from their houses, which, according to the historians, were commodious and tasteful, though not luxurious as we consider things to-day. Their wise men were learned; the Spanish fathers burned their books without knowing what they contained. In their foolish estimation they had a right to destroy that written knowledge because the authors did not believe in their particular divinity! How narrow is human intellect where theology is concerned!

The Maya artisans were clever, the laborers industrious. As for that virtue *which covereth a multitude of sins*, in every city there was an asylum for the aged, crippled, and infirm, policemen being employed to look for them, and conduct them to the desired shelter. The strong and healthy worked together in community, sharing equally the result of their labor.

Regarding their amusements, Father Cogolludo, who has written a most interesting work on Yucatan, tells us that that were clever actors, remarkably witty, and very sarcastic, often telling hard truths to their superiors, and in such language that no one could accuse them of having done so—at times conveying their whole meaning in a single word. But it is to the historian Herrera that we are indebted for a description of some of their pastimes. They had large gymnasiums, where the people congregated to be amused by athletes and agile gymnasts—the aborigines of the present time climb and stand in very dangerous places without fear or hesitation. In one game a ball was to be received on the hip, and by a peculiar movement made to rebound from it without being touched by the hand. He who succeeded in thus casting it from him, causing it to pass through a certain stone ring, had a right to seize the cloak of any one present. On such occasion there was a general scamper that gave rise to much fun, for no one cared to forfeit his mantle and ransom it afterward. This garment was called *tilma*, and was simply a square cloth tied with ribbons by two corners on one shoulder; some were very costly, beautifully woven like damask. Even yet, the Indians when at work secure their shirts by tying the sleeves on one shoulder; and the *tilma* is still used by certain Maya tribes.

The gymnasium at Chichen consists of two long walls, forty feet high, and thick enough for two large carriages to

roll on abreast. About the middle of each wall, projecting from near the top, was a stone ring; one is yet in place, the other fallen, and eight strong men with difficulty raise it from the ground. Entwined rattlesnakes are sculptured on its sides, with crowns on their heads. One of the uses of these rings was no doubt the game described by Herrera.

At the north end of the gymnasium there is a structure that may very well have been a box from which the royal family witnessed the games. The front half of the roof was supported on round stone pillars, still in place, with figures of warriors and other designs sculptured on them. The back wall and sides of this box are covered with bass-reliefs that do great credit to the dead and forgotten artists. They represent human figures in various dresses and attitudes, and landscape. There is one face with Semitic features and full beard. There is not the least doubt that a bearded race dwelt here, for many bearded men are carved in stone, and nearly all seem to be in the act of worshiping.

On the south end of the east wall of the gymnasium a monument was built to the memory of a certain individual, and it seems that no time, labor, or expense was spared in beautifying it. The most patient laborers, cunning artificers, and clever artists taxed brain and body at that work. This is apparent even yet, though for the last thousand years at least it has been abandoned, and, what is worse, purposely damaged, first by invaders, and then by foolish iconoclasts.

Your most obedient,

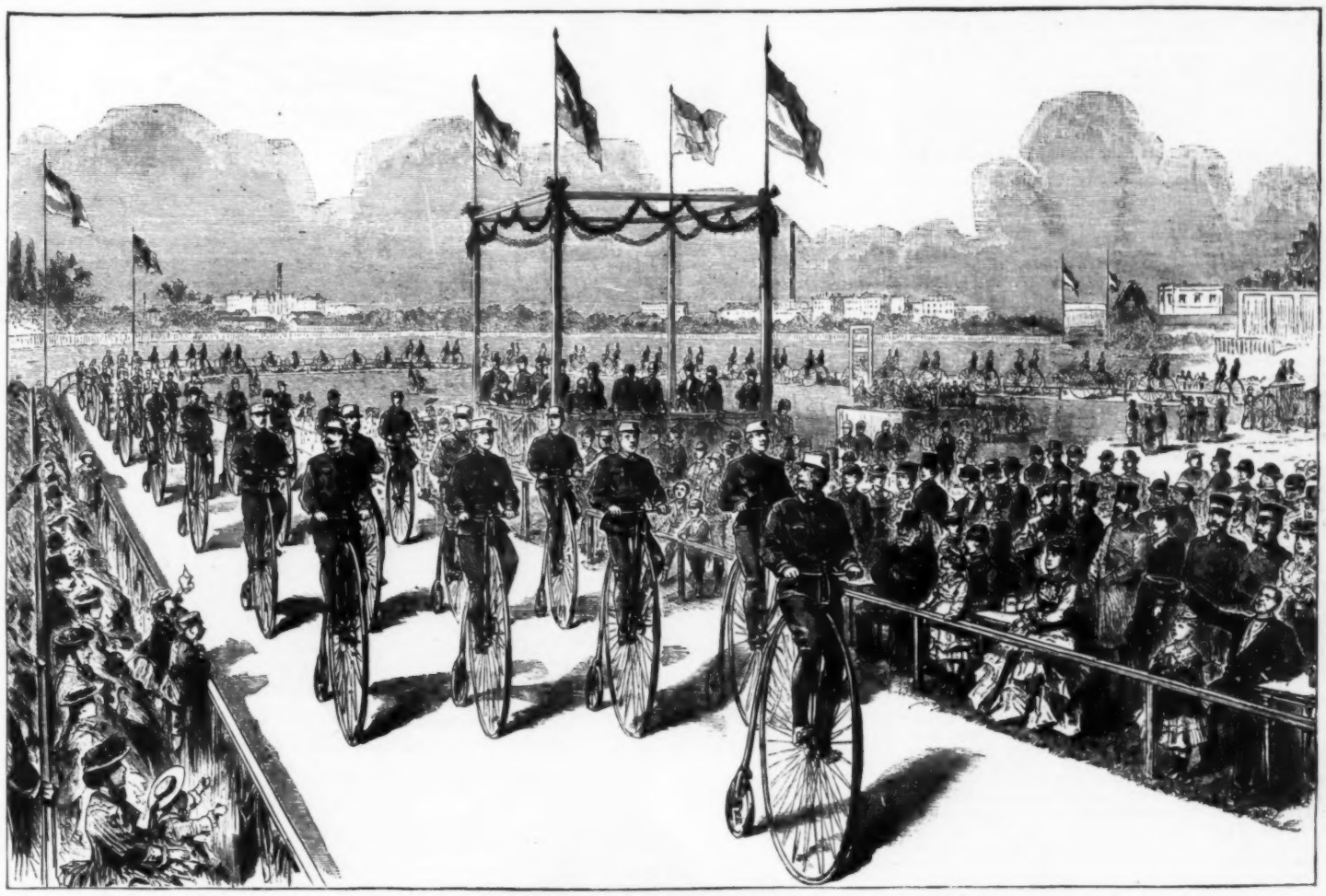
ALICE D. LE PLONGEON.

Ruins of Chichen Itza, Yucatan, Jan. 12, 1884.

THE NEW BICYCLE RACE COURSE AT LEIPZIG.

ON the 1st of June, the new velocipede race course at Leipzig was formally opened by a grand "Corso," which is represented in the annexed cut, taken from the *Illustrirte Zeitung*.

The first attempts at velocipede riding were made in Leipzig about fifteen years ago, but did not find many admirers. Gradually the riders increased, the Leipzig Bicycle Club was organized and now they have provided a good track, at the end of the so-called "Rosenthal." It has the shape of an ellipse, and is about 1,312 feet long and from 13 ft. to 16 ft. wide. Suitable stands for the spectators and judges have been provided.



THE NEW BICYCLE RACECOURSE AT LEIPZIG.

THE SCIENCE OF FASHION.

No one, we believe, has yet attempted to reduce the fashions of the day to a science. Fashion is spoken of as erratic, and has not been supposed to follow any fixed rules, or be governed by any law except that of eccentricity. No philosopher has yet discovered its underlying principles, no mathematician ever calculated its orbit, for its elements have been too little known, the subject having received very little attention from the educated and thoughtful portion of the community.

While science is regarded as manly, serious, and useful, fashion is considered effeminate, frivolous, and useless. A scientific woman was, until recently, a rare phenomenon, and even yet they are none too plentiful; science has been looked upon as man's province. To be a woman almost implied being fashionable, and while men of fashion are none too rare, women of fashion are much more common.

There are fashions in science, if we may call them so, and scientific investigation runs in ruts. Too many of the followers of Tyndall, and Huxley, and Helmholtz are blind partisans of their leaders, and prate of germs or protoplasm without any serious reasons for the faith that is in them.

There are fashions in education, and school boards put one study in the curriculum to crowd another out in obedience to the dictates of the prevailing fashion. At one time coeducation, at another manual labor; at one time literary pursuits, at another the study of nature, forces its way into the school.

There are fashions in eating and drinking, both as to time and quality; there are fashions in living, in rising and retiring; there are fashions in building, and architecture yields obedience, devising new styles or reviving old ones, to suit the dictates of fashion, falsely called changes in taste.

In most cases it is not difficult to trace the origin and development of the various fashions above referred to, their immediate cause being manifest.

Important and astonishing discoveries of talented men set the fashion for the scientific world. New and useful inventions of ingenious men revolutionize the practical world, and set men thinking; the result is a change of educational systems. But neither the discoveries of the one class nor the inventions of the other are able to produce much effect upon the world unless other circumstances have conspired to prepare the way for their reception. History is full of examples of men who lived before their time, of discoveries and inventions made too soon.

Such men left no impress on the times; they were not able to set the fashion, even in their own narrow circle. When the time comes for a certain invention there are usually plenty of men ready and able to make it, hence the telegraph, the steam engine, and the telephone were invented almost simultaneously and quite independently, by several different persons.

In matters of dress the vagaries of fashion find free play and wide scope. Her most arbitrary commands receive implicit obedience from a large portion of the civilized world. Whether her dictates are cruel or mild, the styles that she devises comfortable or the reverse, graceful or stiff, healthful or harmful, pretty or hideous, pleasing or distressing, there are plenty who are ready to submit to the yoke and bear it cheerfully.

Who is this imperious leader of fashion that is able to rule with a rod of iron? Is it some earthly potentate, a queen, an empress, the demi-monde, as we are so often told, or is it Worth, the man milliner of Paris? Is it the daughter of some millionaire, or some crafty female Gould or Vanderbilt? Who and what is this mysterious person that is supposed to dwell in Paris and design all the fashion plates for Europe and America?

From time to time we read of such or such a person as "setting the fashion;" once it was the French Empress, at another time some queen of beauty or stage star. But these ladies were, after all, but the outer, visible, and tangible instruments through whom the fashions reached the public gaze.

Perhaps they had in their employ some ingenious person who was able to originate some minor detail, to add a flounce or tie a bow, to modify a well-known shape and render it more attractive. But no new and utterly unheard of costume ever made its advent in this way. Had the French Empress appeared in a Quaker bonnet or a Turkish fez, it is doubtful if the world had followed; on the other hand, had she adopted trousers, or knee breeches, or tights, she would at once have lost her hold on womankind. It was by keeping within the limits that fashion herself set, that she obtained and preserved her sovereignty as the queen of fashion.

Many a lady of rank has attempted to popularize some particular article of dress, but unless it met some acknowledged want and was in harmony with the spirit of the times she failed. Every attempt at dress-reform fails if in advance of the age. Even Lady Hammerton's "divided skirt," although concealed under an undivided dress, grows very slowly in favor, even in England.

It must be evident to every student of fashion, who watches the growth and decay of each succeeding style, that there must be a "power behind the throne," some governing and directing force, some peculiar combination of circumstances as yet unknown and undescribed, which conditions even so fickle a dame as Fashion.

The slight and ever recurring variations in one species of animals or plants will, by cumulation through natural selection, survival of the fittest, and other natural causes, finally lead to a new species. May not similar causes produce a like effect upon the growth and development of fashions? Some fashions are temporary, others recurrent, still others permanent and progressive.

A new and peculiar style that awakes no response in human nature, that fills no gap and gratifies no instinct, soon sinks from sight and is buried in oblivion. Many fashions are, however, periodical, returning at regular intervals. Among these we might mention crinoline and narrow skirts for ladies, baggy trousers and skin-tight pants for men, which alternate with the greatest regularity, each style in turn serving a useful purpose and satisfying at least one portion of the people.

High heels alternate with low ones, sharp toes with broad, hats take the place of bonnets, the latter grow larger and larger, then shrink to insignificant size, flowers take the place of feathers, gay colors alternate with sober ones, and a pleasing variety results. The eye tires with sameness, and the body wearies with one kind of exercise, hence changing fashions, like change of scene or of season, are pleasing to all persons.

Those fashions which do not rotate but are steadily progressive in some particular direction, must have a higher mission, or else be conditioned by causes rooted deeply in our civilization or in human nature. The differentiation in the dress of the sexes has been going on steadily for centuries, conditioned probably by the increasing differences in the habits of each.

Among barbarous or half civilized nations, as among children, there is little difference in the dress of the sexes. Among the Eastern nations, the difference is less marked than with Europeans, and was less formerly than now. But a few centuries ago Englishmen indulged in silks and laces, they padded, they laced, they wore ruffles and wigs, bright rainbow hues found favor with them then, and they were not ashamed to expose their nether extremities. Such costumes are now confined to court ceremonies, and it is improbable that they will ever come in fashion again. The average dress of the present day, varied slightly by periodic changes that cause it to vibrate a short distance to the right and left of the middle course, seems to possess remarkable stability.

It has been evolved in the course of centuries, mostly by the unconscious acts of the masses, guided by some mysterious power. Although few are willing to acknowledge that it possesses much real excellence, and certainly it is far from perfection, yet it seems destined to sweep all others from the face of the earth. A fashion that can hold its own for centuries and convert all other nations to its use must possess some peculiar fitness, some excellence, some hidden power yet unrecognized, that gives it stability.

It is generally believed that fashion runs counter to the wishes of the majority, to the dictates of reason, to the highest ideals of truth and beauty. Artists, physicians, and economists attack one fashion after another without effect; kings, popes, and priests have fought in vain against partic-

ular fashions; they not only held their own, but gained strength by opposition.

No article of male attire has excited more ridicule, no article is less useful, less beautiful, or less comfortable, than a "stove-pipe" hat, and yet its popularity increases. It is one of the first articles adopted by the Japanese and other distant people on their arrival here. Among articles of female attire, corsets and crinoline have met with all manner of opposition. Hoops come and go like other rotating fashions; one person finds them comfortable and becoming; for a time her party rules, and hoops are worn until her rival, who looks and feels better without them, succeeds in overthrowing them and establishing her own contracted style of drapery.

The natural tendency of each style to run to a ridiculous extreme favors a return to the other, just as in the state too stern and severe a law defeats itself and leads to its own repeal. The corset, however, reigns supreme at all times and with every fashion; long waists and short ones, full waists and plain ones, thick dresses and thin ones, are all fitted over corsets.

It would be hard to tell what makes this one article so dear to the female heart. Black and white, native and foreigner, rich and poor, mistress and maid, glory in them. Wherever European civilization extends, the corset soon becomes popular. A Cairo correspondent of *All the Year Round*, describing a Cairene bride, mentions the significant fact that the sister of the bride has advanced to the civilized length of wearing high heels and tight stays. It would seem that the day is not distant when the ladies of the harem will add a pinched waist to their other charms. An article that fights its way against every odds for fifteen centuries and is at once adopted by other nations, needing only to be seen to be appreciated and adopted, must possess some peculiar merit that does not appear on the face of it. It fills some long felt want, it satisfied some natural instinct, probably by furnishing an easy and comparatively painless method of "improving" the natural shape of the person, less cruel than the Chinese foot squeezing, which promises soon to go out of use, and having the advantage that it can be applied by the person herself instead of her parents, and does not cripple or unfit her for future usefulness.

The fashion of using tobacco is almost parallel to that of pinching the waist; although it has not been in use half so long, it has reached all quarters of the globe. The taste for both must be acquired; the first effects are unpleasant, and yet most people persevere in their use until the habit is too strong to be broken.

We have spoken of our present style of dress as settled, and so it seems to be in its main features, but in details we find encouraging evidence of development, some of which means improvement. Among men we may refer to the substitution of buttoned shoes for long boots, among ladies of high shoes for low ones, and thick soles for thin. The introduction of cork-soled boots for both sexes will gradually drive out the unhealthy rubber shoe. Women are imitating the dress of men in such particulars as are worthy of imitation, and it is to be regretted that men are not willing to do the same, as this would certainly result in the total abolition of the white shirt, which was once useful, but has now become an expensive nuisance, the only use of which, beyond being a foundation to which collars and cuffs may be attached, is as food for profanity. Women don't wear them. Why should the men?

A history of the shirt, if it could be written, would be a curious chapter in evolution applied to an inanimate object.

When the history of all articles of dress has been studied from this point of view, we shall have the material for tracing the evolution and development of fashion, and reducing it to a science.

FRENCH BARREL-MAKING MACHINERY.

We illustrate herewith a series of machines for making barrels and casks, the invention of Messrs. Arbey & Sons, of Paris.

We shall tell how a cask is made by describing the successive machines that are used in its construction. Passing over the saw that serves to cut the wood into slabs of the proper dimensions, we come to the machine that is to form the bulge and make the joint shown in Fig. 2.

The bulge is the curve that is to be given to the staves, and it is important to remark that the joint of the latter must be a diametral plane, and that two consecutive planes form an angle whose apex is at the center of the cask. Each of these planes must be inclined upon the face of the slab. This result is reached with the machine under consideration (Fig. 1) as follows: The essential part of the apparatus consists of a frame that is seen at the upper part of the cut. This frame rests upon the table of the machine through the intermedium of two supports which contain the axes of oscillation of the frame, so that the latter has an oscillating motion backward and forward and around a horizontal axis. The extent of this motion is determined by the width to be given the staves, and it is fixed by means of two screws moved by a hand wheel that may be seen to the right of the cut. This extent regulated, the slab is placed upon a curved piece that has the form of the stave, and that is affixed to the oscillating frame by means of bolts. After this, another piece that has the same curve is made to descend upon it by means of a screw and hand wheel. This compresses the slab and gives it the shape that it is afterward to preserve. The stave once fixed, as we have described, the frame is inclined in such a way as to make it rest against the hind stop, and a circular saw that moves in a vertical plane is then caused to run forward and cut the edge of the stave according to the diametral joint plane that we have mentioned above. This done, the saw is moved to the right, the frame is inclined in the opposite direction, and the other edge of the stave is cut in the same way. We thus get a stave of a definite width whose joint planes will match those of the other staves. But, to return to the machine: The curved part that is designed for giving the bulge rises at its two extremities in such a way as to allow the saw to pass when the frame is tilted for cutting on one side or the other. This saw is mounted upon a sort of two-forked connecting rod. The double upper fork holds the saw, a horizontal piece serves as a guide, and the lower fork rests upon the shaft of a large pulley, which, through the intermedium of a belt and an upper, small pulley, runs the saw. The latter, aside from its circular motion, has an oscillating one around the axis of the large pulley, so that it accurately describes the curve of the bulge. The saw is made to describe this arc by means of handles fixed to the rod that carries it. The staves having been formed, it becomes necessary to join them and hold them together provisionally. This is done by means of the machine showed in Fig. 2, which consists of a frame that carries two vertical screws that are capable of being revolved by means of conical gearings situated be-

Fig. 1.—STAVE MACHINE.

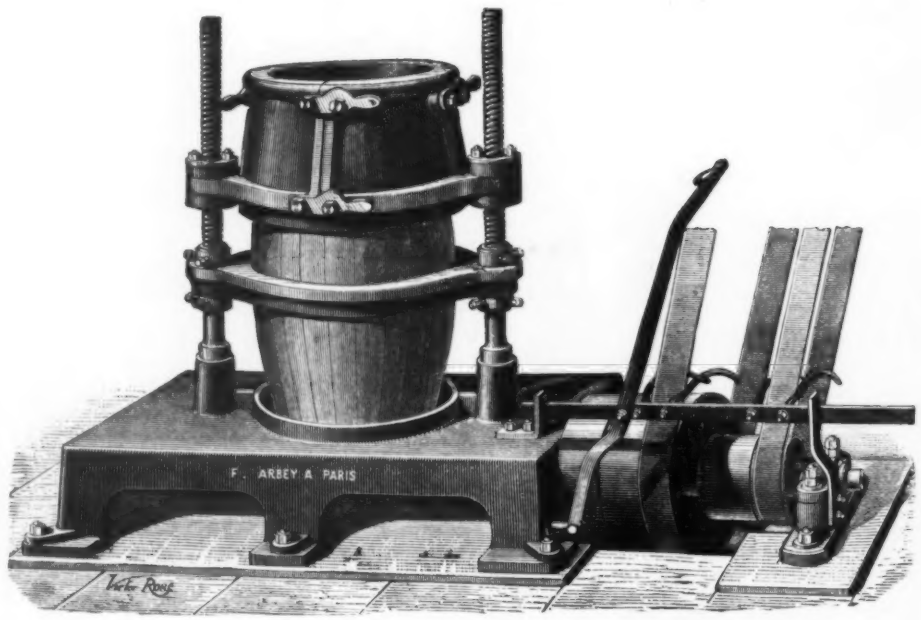


Fig. 2.—STAVE JOINER.

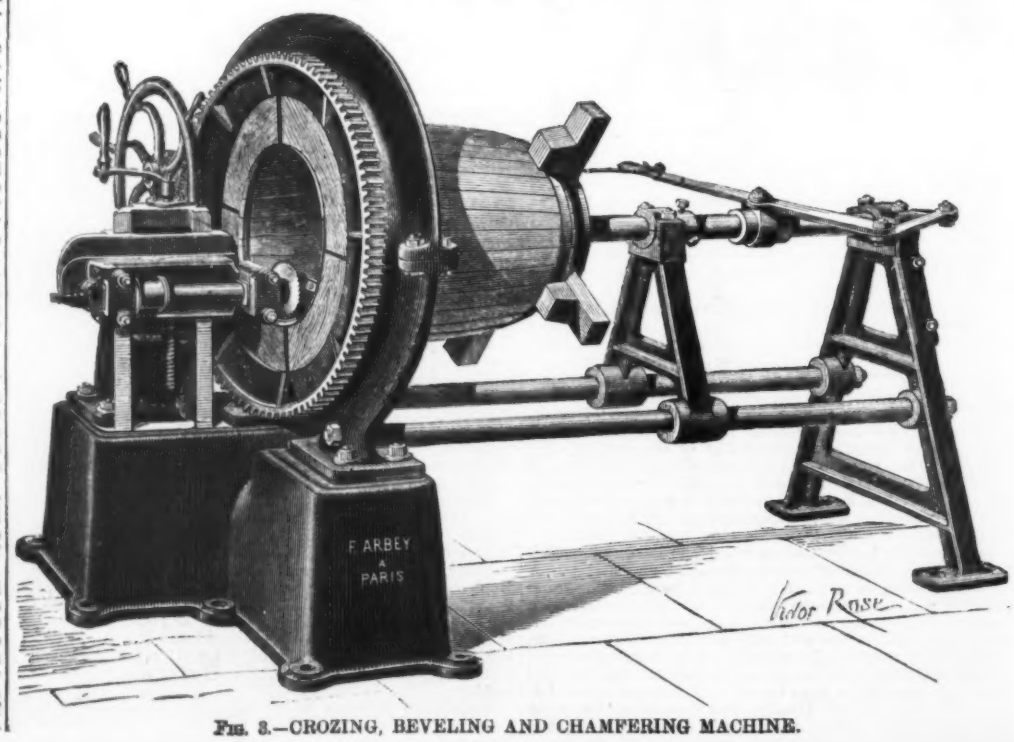


Fig. 3.—CROZING, BEVELING AND CHAMFERING MACHINE.

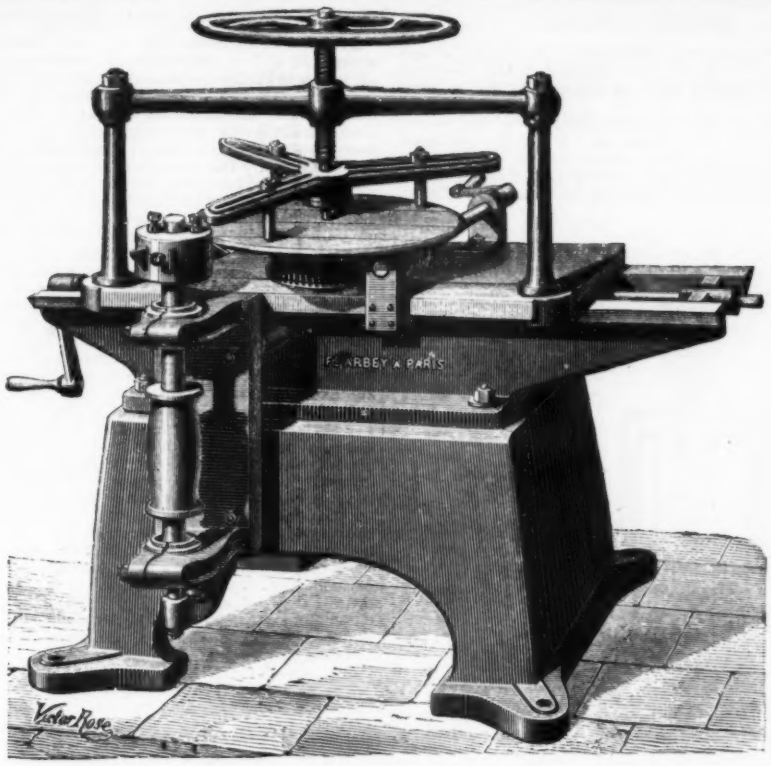


FIG. 4.—HEAD FINISHING MACHINE.

FIG. 6.—CROZING MACHINE.

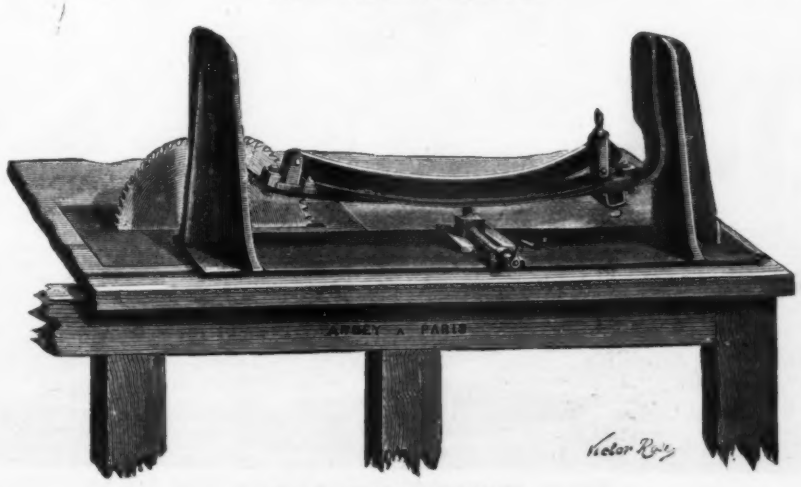


FIG. 5.—STAVE MACHINE.

beath the bed-piece. To the base of these screws there is fixed a circular collar, against which are placed the staves in such a way as to form a cask. Above this collar there is a cast iron piece consisting of four parts that are connected by catches, and each of which carries a nut that works upon the screw. This cast iron piece carries an iron hoop in a groove made for the purpose. When, therefore, motion is communicated to the screws, the nuts descend and force the hoop over the staves. This done, the catches are unfastened, the cast iron piece is removed, and we thus have half a cask furnished with provisional hoops. The cask is then inverted, and the same operation is again performed. The cask, provided with its temporary hoops, is then carried to the crozing, beveling and chamfering machine, shown in Fig. 3. Here it is placed in a ring and firmly held by means of a wooden disk that is shoved up against it by means of a lever which is jointed to the other extremity of the frame. The wooden ring in which the cask is fixed is concentric with an iron crown wheel which is revolved by means of a hand wheel of large diameter. The pressing disk in nowise interferes with the rotary motion of the cask, since the pressure is transmitted by means of a collar that permits of its rotation without allowing it to move longitudinally.

The croze is formed by means of a circular saw which is mounted upon a shaft that gets its motion from the engine of the establishment, and is fixed to a carriage that is moved by a screw and slides along a vertical guide bolted to the frame. The beveling and chamfering are done at the same time by tools mounted upon the same shaft.

When one of the ends has been notched, beveled, and chamfered, the pressing disk is taken out, the cask is turned end for end and locked in the ring as before, and the same operation is again performed. The cask is now ready to receive the heads, which have been prepared in a special machine.

After the pieces that constitute the head have been cut out and grooved, and holes have been bored in them for the reception of pegs for coupling them, in a machine not here shown, they are joined together and taken to the machine shown in Fig. 4.

This machine consists of a frame upon which slides a carriage that is moved by a screw. This carriage carries a circular plate provided with a crown wheel having helicoidal toothing and receiving its motion from a tangential screw actuated by a winch. This disk has a point at its center and three others at angles of 120°, upon which the head is placed and which serve to communicate to it the rotary motion given by the screw. In order to fix the head properly upon the disk, a pressure is exerted by means of an arrangement that will be readily understood from an inspection of the figure.

Against the frame there is bolted a support that carries a vertical shaft, which is provided at the center with a pulley, and at the upper part with a tool-carrier to which are fixed two triangular tools designed for making the double bevel and a straight tool for forming the diameter. As this shaft makes from 1,000 to 2,000 revolutions per minute, the head is finished very quickly. Then the temporary hoops are removed from the cask, the heads are put in, and the final hoops are put on by means of a machine analogous to the one shown in Fig. 2.

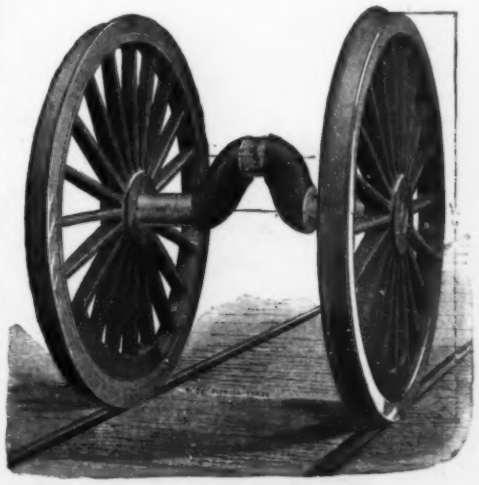
The process of making barrels for packing dry materials in is a more rapid one. The method is the same, and the apparatus are nearly so, although simpler. We shall describe but two of the machines used—the circular saw for forming the bulge, and the crozer.

As regards the saw, it is arranged like the other, the guide alone differing (Fig. 5). It consists of two supports that carry the axes of oscillation, and of a lower curved piece for giving the bulge. But here it is necessary to turn the piece of wood over in order to make the joints of the two sides.

The barrel is put together as before, and is placed upon the crozing machine shown in Fig. 6. Here the barrel rests upon a crown wheel which is actuated by a cone wheel, and the croze or notch is formed by a tool placed within the interior, as shown in the figure, where a portion of the barrel is represented as removed in order to make the explanation clearer. The barrel is held by an upper plate which is pressed against it by means of a screw and a hand wheel.—*Chronique Industrielle.*

CAST STEEL LOCOMOTIVE DRIVING WHEELS.

MR. F. H. WEBB, of the London and Northwestern Railway, Crewe, writing to *The Railroad Gazette*, says:



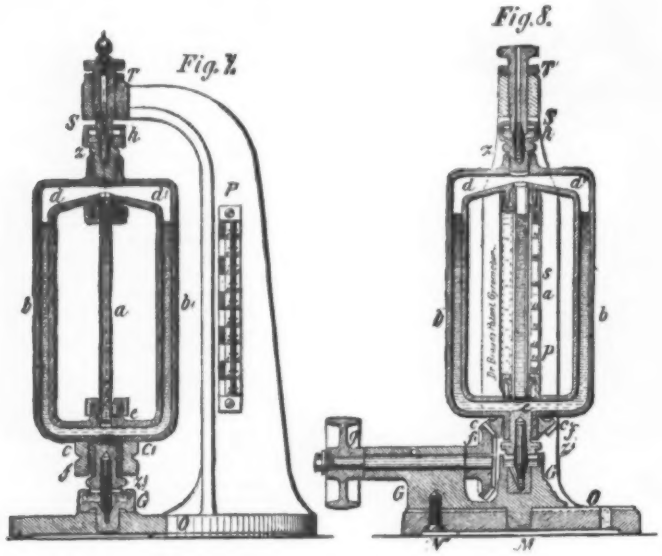
CAST STEEL LOCOMOTIVE DRIVING WHEEL.

I inclose a set of photographs of solid cast steel wheels, the same shape and dimensions as we formerly made in wrought iron, as I am now using them in the compound express engines. In America I know there has been a great objection to a crank axle as a rule, but I think if they study the form of the crank axle of the compound engine, they will see that it becomes a very simple affair, and we are now bending them under our hydraulic presses from the plain round bar in a few minutes. Of course our balance weights are cast in, and we find no difficulty in making the wheels perfectly solid.

A NEW SPEED INDICATOR.

The speed indicator shown in the accompanying illustration was devised by Dr. Braun to obviate some of the difficulties met with in other constructions, and it belongs to that class which apply the action of centrifugal force upon liquids.

The machine consists of three tubes, *a*, *b*, *b*¹, which connect freely with one another, and are mounted vertically between conical centers. The tubes are sealed air tight so that no liquid can escape or be added. A scale is placed on the



A NEW SPEED INDICATOR.

standard opposite the central glass tube, and is graduated to correspond to various speeds. When the apparatus is set in motion, the level of the colored liquid falls in the central tube *a*, and rises in *b*, and *b*¹; by comparing the level of the liquid in *a* with the scale, the speed can then be read off.—*Deutsche Ind. Zt.*

THE ARMORED FRIGATE TEGETTHOFF.

The Austrian navy was reorganized in 1866, and lately has been provided with torpedo boats. The maneuvers of the Austrian navy began June 1, under the command of Vice-Admiral Von Sterneck, and took place in the neighborhood of Pola, Fasana, Rovigno, Parengo, and Triest. The armored frigate Tegetthoff, which is the flag ship of the Austrian navy, is represented in the annexed cut taken from the *Illustrirte Zeitung*. The Tegetthoff, like all other armored vessels of the Austrian navy, is a broadside vessel.

BRONZE CASTING.

The following technical description of the method of casting bronze "a la cire perdue," as carried on by the Compagnie des Bronzes at Brussels, has been prepared by Sir J. Savile Lumley.

Supposing the work to be reproduced to be the portrait bust of a man with curly locks and a long flowing beard, such a head would not be easy to cast by the ordinary process owing to the difficulty of conveying the liquid bronze into the cavities of the curls and the interstices of the beard, but this is easily overcome when the bust is cast by the wax process. The different operations to be carried out are as follows: 1. The production of the model in plaster or terra cotta by the artist sculptor. 2. Its reproduction in wax by the founder. 3. The repairing and retouching of the wax bust by the artist sculptor. 4. The preparation for casting the bust before forming the mould and cope. 5. The formation of the mould. 6. Firing. 7. Casting. 8. Finishing and decorating the bronze bust.

I. THE MODEL.

The bust produced by the sculptor, which may be in terra cotta or plaster, finished as far as the artist thinks advisable, is handed over to the founder.

II. THE REPRODUCTION IN WAX.

This requires three distinct operations: A. The formation of a piece mould. B. The reproduction of the bust in wax. C. Running the core.

A. THE FORMATION OF A PIECE MOULD.

After having examined the bust so as to be thoroughly acquainted with its difficulties, the workman proceeds to cut off with a twisted wire the projecting portions of the beard and the hair, which, from the cavities of the locks and curls, would present difficulties for casting. The parts thus removed are afterward easily replaced. The bust is now reduced to a very simple instead of the complicated form it at first presented. The plaster mould is then made in the ordinary way: the bust being laid on a table, face upward, is fixed in that position by lumps of modeling clay so that one half of the thickness of the bust is completely covered, the remaining half presenting the appearance of a figure floating on its back in water. The workman then begins to make the pieces of the mould; taking the liquid plaster, which is of the consistency of thick cream, he forms a cube 5 centim. high, and the same length and width, which he squares as soon as the plaster begins to harden; with this cube of plaster he covers a first portion of the surface of the bust; close to this first cube a second is formed, and so on until the whole bust is covered with an irregular mosaic of plaster cubes, care being taken to prevent them from adhering to each other or to the bust by the application of a strong solution of soap. The surface of these cubes, after being well wetted with this solution, is covered over with a very thick coating of plaster, which is called the cope, the place of each cube having been previously marked; the first half of the piece mould is now complete. The moulder then turns the bust with the face down on to the table, fixing it as before, and proceeds to cover the back in the same way with cubes of plaster, so that when this second half is also covered with a thick plaster cope, a complete mould is formed in two halves. The great art of the moulder is to make the piece moulds at the same time simple and solid, and fitting so closely together as to leave the least possible trace of the joints on the plaster cast produced from it; care must also be taken that in handling the mould none of the small pieces should detach themselves from it.

The mould being completed, it is opened, that is to say, the two plaster copes are separated, the bust, which is intact, is taken out, leaving a complete mould in which other busts can be cast just as bullets are cast in a bullet mould.

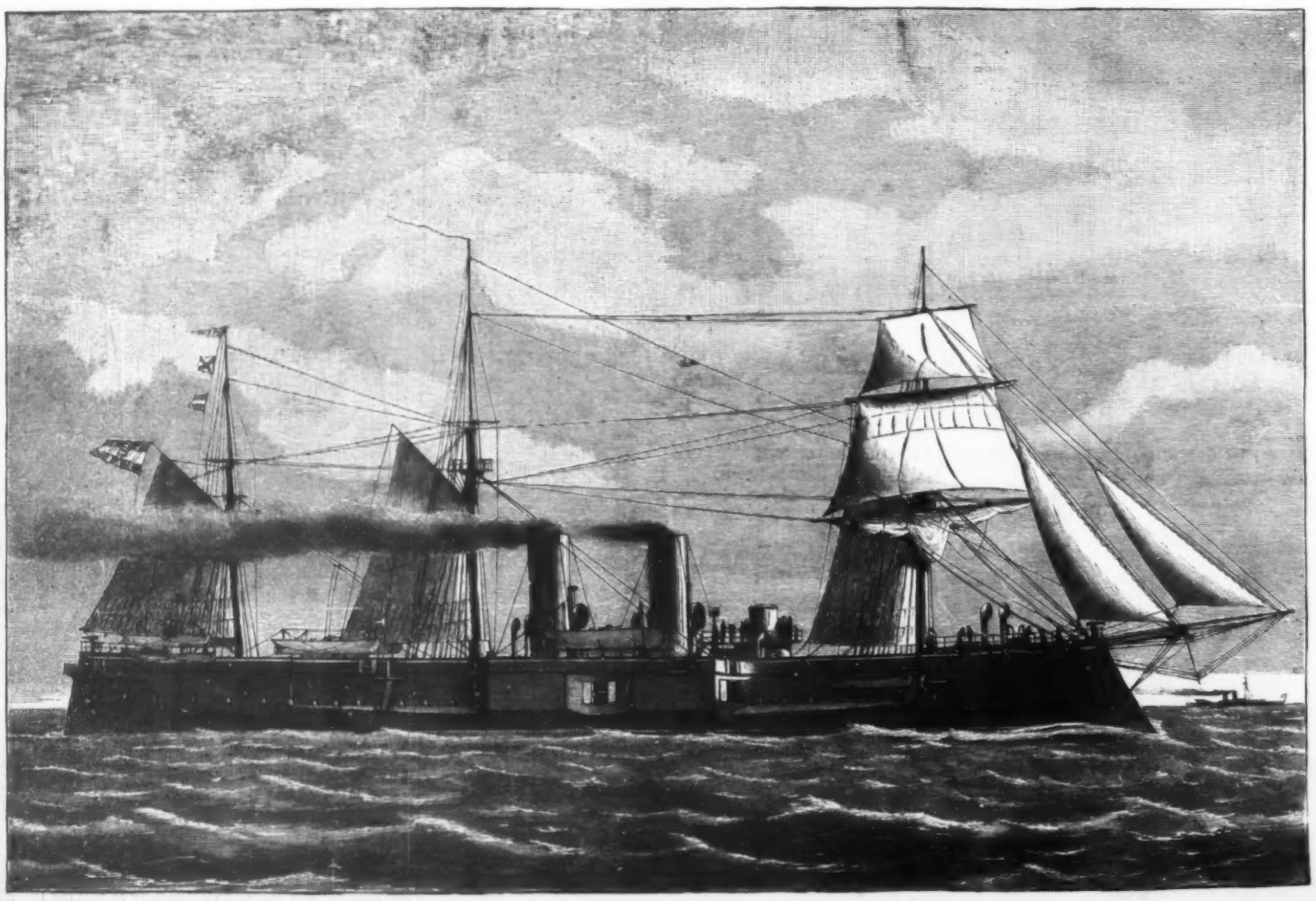
The next operation is the reproduction of a bust in wax, precisely like the original in plaster.

B. REPRODUCTION IN WAX.

One-half of the piece mould is placed on the table, that is to say, one of the copes, with all its pieces, and the mould is wetted with water in order to prevent the wax from adhering to it; the workman then, with his thumb, presses wax into all the hollows of the mould—this is an operation of considerable delicacy. The wax, which must be very pure and malleable, is affected by the weather, working more easily in summer than in winter. The most suitable quality for average temperature is composed of 1 kilog. of yellow wax, 6·200 kilog. of mutton fat, 0·100 kilog. of white pitch, melted together and colored a deep red with orcanette root.

The wax pressed into the mould should be 2 millim. thick. When all the hollows of the first cope have had wax of the requisite thickness pressed into them, the same process is applied to the second cope; the two copes, on being united, form a complete mould; they are then tied together with strong cords, and the joints of the copes are smeared with clay so that the mould should be watertight.

In the mean time another description of wax of harder consistency, composed of 1 kilog. of yellow wax, 1 kilog. of resin, and 0 250 kilog. of Venetian turpentine, has been melt-



THE AUSTRIAN WAR STEAMER TEGETTHOFF.

ed in a caldron and allowed to stand on the fire until the froth has subsided.

The wax being ready is allowed to cool to 60 or 70 degrees Centigrade, when it is poured into the mould, which it fills, and is allowed to remain there for 40 seconds; the liquid wax is then poured out of the mould into a bucket prepared to receive it. On examining the interior it will be found that the soft wax which was pressed into the mould has received throughout a coating of strong wax 3 or 4 millim. in thickness, making an entire thickness of 5 or 6 millim., which will be the thickness of the bronze when cast.

C. FORMATION OF THE CORE.

The core is the substance with which is filled the hollow left in the mould after the liquid wax is poured out of it. If the bust were cast in bronze without a core, it would come out solid and weighing ten or fifteen times heavier than is necessary, and the casting itself would be faulty owing to the great shrinkage produced by such a mass of molten metal, which would also have the effect of vitrifying the earths forming the mould. The core is, in fact indispensable in the reproduction of artistic bronzes. The core in use at the Brussels Compagnie des Bronzes is formed of a mixture of two parts of fine plaster of Paris and three parts of a pulverized earth composed of quartz sand, thin argillaceous clay with traces of iron oxide, carbonate of lime, magnesia, and potash, mixed together with pure water, forming a liquid paste which is called "potin," and which like plaster of Paris hardens very rapidly.

Having calculated the capacity of the hollow left by the wax, a quantity of "potin," sufficient to fill it, is prepared and poured into the hollow, leaving enough of the mixture to form a pedestal projecting about 10 centim. from the bottom of the bust. The core having been thus poured into the hollow, is left to harden.

Before proceeding further it is necessary to describe the means by which an escape is provided for the air or gases of the core, which, if not set free, might destroy, twist, or otherwise injure the bronze.

This is effected by what is called, in the language of the foundry, a "lanthorn," or chimney, by which the core of every work in bronze must communicate with the external air. The core being composed of porous matter it is easy to understand that when the molten metal enters the channel prepared for it, the core being completely isolated and superheated, the gas within it is violently dilated, and would force a passage through the fused metal if a vent were not prepared for it. If, owing to an accident or faulty arrangement, the lanthorn should not act, the bronze figure containing the core would be inevitably bulged and distorted, and would have other defects which would considerably diminish the value of the work

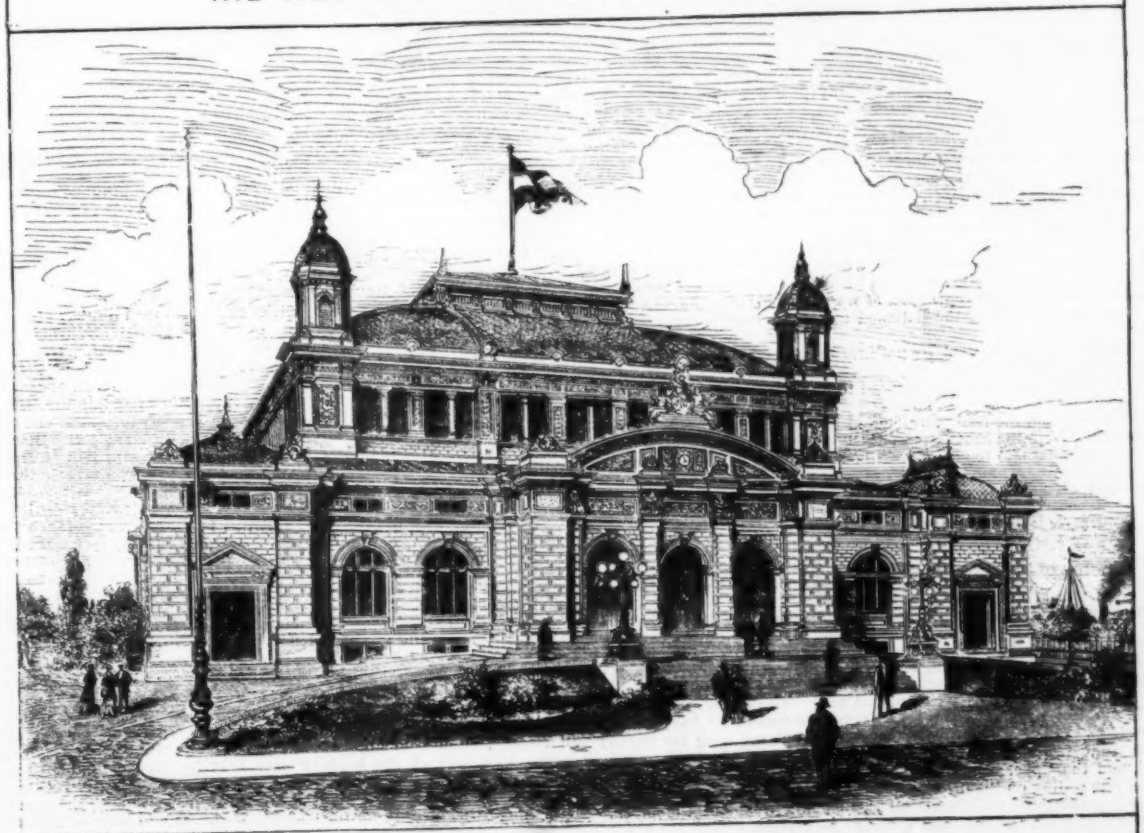
In the case of the bust already described, when the piece mould is emptied of the liquid wax that has been poured into it, and just as the "potin" which is to form the core is about to be poured in, a round stick, about 16 millim. in diameter, having a pin or iron point at the end, after being well oiled, must be fixed into the center of the hollow of the bust, so that the pin should project through the wax of the top of the head. The stick must be held in this position while the "potin" is poured in around the stick, and when the "potin" begins to harden, which it will do in a few minutes, the stick is twisted out, leaving, of course, a hollow the size of the stick traversing the bust from the base to the head. After the artist-sculptor has retouched the wax bust, the mark left by the point of the stick is sought, and sufficient wax is removed around it to permit of a small iron tube of the same diameter as the hole left by the stick being forced two or three inches deep into the head, leaving, however, a portion projecting from the head and beyond the block mould when it is formed over the wax bust.

Any crack that may appear between the tube and the hole is carefully closed, and the wax is retouched where the tube projects from the head.

If the tube were not forced sufficiently into the head, or if the joint were not properly closed, the molten bronze would find a passage and fill up the chimney left for the escape of air from the core—an accident which would give rise to effects like those above referred to.

In complicated pieces the proper formation of the lanthorn is of the greatest importance; it is often difficult to ar-

THE RUDOLPH ACADEMY OF ARTS, PRAGUE.



THE NEW TOWN HALL MENTZ. HERR KREYSSIG CITY ARCHITECT

range, and requires considerable experience to make and place it properly.

I am unable to give the precise proportions of the earths of which the "potin" is composed, which is in fact the only part of the process concerning which any reserve is shown.

The mould is then placed on the table, the cords are unfastened, the clay closing the joints of the two copes is removed, and by inserting a wedge between the two copes the upper cope is carefully lifted off. The workman then removes one by one all the little pieces forming the mould, exposing the corresponding parts of the bust in wax. When all the pieces are removed from the front, the bust is placed upright on its base of "potin," and the cope covering the back is then removed in the same way, together with the pieces forming the mould.

These pieces are then carefully returned to the cope each in its place, and the mould, when put together again, is ready to be used for another wax bust when required.

The bust now appears in wax, reproducing exactly the original bust in clay, with the exception of the seams from the joints of the mould, which are then removed by the artist-sculptor himself.

Although wax is neither as easy nor as pleasant a material to work in as modeling clay, a very short time suffices to enable the sculptor to manipulate it with facility, and an opportunity is afforded him of giving the finishing touches to his work with still greater delicacy than in clay.

It is at this period that the beard and curls of the hair, which were removed before making the mould, and which have been separately reproduced in wax by the same process, are fixed in their respective positions by iron points, which are driven through the wax into the solid core, and hold the pieces firmly in their places; the artist then going over the joints with a modeling tool renders them invisible.

3. RETOUCHING THE WAX BUST.

The great advantage of reproducing the bust in wax is that it enables the artist to work upon it, so that the wax bust is not only equal to the original in plaster or terra cotta, but may become even superior to it; for the artist, on seeing his work in a material of another color, and after a certain time, may discover certain faults which he can correct in the wax, or, if he thinks it necessary, he can make such alterations as he may consider advisable.

4. PREPARING THE BUST BEFORE MAKING THE CASTING MOULD OR COPE.

The bust in wax having been looked over and corrected by the artist, is now placed in the hands of the founder, who begins by building a layer of firebricks of the size required for the object that is to be cast; this layer, for a bust, may be 1 meter by 80 centim., and 0·25 centim. in height above the floor of the atelier. When ready, the wax bust is placed upon it on its pedestal of "potin," and firmly fixed to the brick layer or base. The next operation is one of considerable delicacy, namely, the placing of the runners or channels to enable the liquid bronze to flow through and fill up the vacant space left by the melted wax, and the vents, which are other channels for the escape of the air and gas driven out of the hollow by the force of the liquid metal.

For a bust the placing of these channels is not difficult, but when a complicated work—a group or a large bas-relief—has to be prepared for casting, the proper position of these channels requires considerable study, for if one of them should be badly placed it would compromise the success of the casting.

In order to make a runner for the bust in question, a stick of wax is used, 0·60 meter long, with a diameter of 40 millimeters, one end of which is cut or flattened into the shape of the mouth piece of a whistle; the other end is considerably thickened by the addition of wax, until it has the form of a funnel; it is then bent into the form of a double siphon, with the two parallel branches considerably lengthened. Having thus prepared the runner, in order to fix it three or four thin iron pins are driven in a straight line, at a distance from each other of 1 centim., into one shoulder of the bust, from which they are allowed to project about 2 or 3 centim.; upon these is pressed the flattened end of the runner, and the joint where it touches the shoulder is then closed with wax, which is melted with a heated tool, thus increasing the solidity of the joints. The vent, which is fastened in the same way on the other shoulder, is a simple straight stick of wax, thinner than that of the runner, also with the flattened end touching the shoulder.

If from any cause the runner and the vent are not firm in their positions, another iron pin is driven into the top of the head of the bust, and the runner and vent are fastened to it with packthread.

The founder has now before him the bust, surmounted by the runner and the vent rising from the shoulders to the summit of the head, like little chimneys, to the height of 15 or 20 centim.; he then proceeds to drive a number of iron pins all over the surface of the bust, through the wax, into the core, the object of which is to maintain the core in its place; these pins must project one-half their length from the surface of the bust.

5. THE FORMATION OF THE CASTING MOULD OR COPE.

The bust thus prepared is placed on the brick layer in the place in which it is to be fired; it is then surrounded by a wooden case, having the form of a four-sided truncated pyramid. This case, which must be sufficiently large to leave a space of from 15 to 20 centim. between it and the greatest projection of the bust, is made of frames placed one upon the other, 23 centim. in height, the whole when placed together having the form of a pyramid; the first frame, namely, that which rests on the brick layer, being naturally the largest. The case being ready, the cube measure of its capacity is calculated, and the upper frames are removed, leaving only the lower one resting on the brick layer.

The mould is made of precisely the same material as that forming the core of the wax bust; the requisite quantity is prepared as well as the proper number of measures of water required for mixing the "potin."

As the operation of filling the frames must proceed rapidly, and once begun cannot be stopped, care must be taken to have a sufficient supply of the material at hand.

For the formation of the cope of a large-sized bust, three men are required for mixing the "potin," two for pouring it into the frames, and two for throwing the mixture on to the bust, which is done with painters' brushes, and in such a way as to thoroughly fill up all the cavities of the sculpture.

The three mixers have each before them a vat or bucket containing one measure of water, into which they pour rapidly the dry "potin," which is in the form of fine sand or powder, and this not all at once, but gradually, by allowing it to fall through their fingers; when the "potin" is all in the water, the men work it into a paste with their hands. As soon as it is ready the other men pour one after the other the contents of the three vats or buckets into the lower frame of the wooden case; in the mean time the mixers are preparing fresh vats of "potin." As soon as the first frame is nearly filled, the second frame is placed above it, the joints being closed with "potin" that has become almost hard, and it is filled in the same way; at the same time the other two men, armed with brushes, have been sprinkling the bust with the mixture so as to fill up completely all the cavities of the wax bust; if this is not done with great care and exactitude, any cavity that is not filled with "potin" will retain a certain quantity of air, and when cast the cavity will be entirely filled up with a solid mass of bronze, which would require to be removed by the chaser at a considerable expense, or it may happen that the fault is one impossible to remedy. When all the frames have been placed one upon the other and filled with "potin," the operation is completed, care having been taken to fill the upper frame only to the level of the top of the runner and the vent, so as not to cover them.

A third channel, required for draining off the melted wax, is formed in the same way as the other two, a stick of wax of 30 millim. in diameter being placed at the base of the bust on the slant, so as to facilitate the issue of the liquid wax, the stick of wax being fastened by one end to the wax of the bust, while the other end touches the wood which forms the case. The "potin" having been allowed to harden, which it does very rapidly, the wooden frames are removed, and the cope appears in the form of a block of stone, on the upper surface of which is seen, on the right, the wax of the runner, and on the left that of the vent, and at the base that of the drain.

6. FIRING.

The block is now ready for firing. A furnace of firebricks is built round it, two chimneys being placed on the runner, and the vent communicating with the outer air, and round this furnace a second is built, in which a coke fire is lighted. The fire should be moderate at first, gradually increasing until the mass is baked throughout, so that it is completely red hot to the very center.

After baking for six hours the block is sufficiently heated to cause the wax to melt, which then escapes through the drain, which is in connection with an iron tube passing through the two furnaces, and communicating with a vat into which the wax flows. When the wax has ceased to flow, the opening from the drain must be carefully closed, in order to prevent any air from reaching the interior, which would be injurious to the process.

After thirty-six hours' firing, puffs of blue smoke are seen issuing from the chimneys. This shows that the heat is sufficiently intense to cause the evaporation of any wax that may have remained in the block. After sixty or seventy hours the smoke changes from blue to a reddish hue; this shows that the wax is completely destroyed. The smoke is succeeded by a slight watery vapor, and the fire is increased until all moisture has disappeared. This is ascertained by placing a cold steel plate over the orifice, upon which the slightest vapor shows itself in the form of a veil or dewlike drops. If at this moment it were possible to look into the center of the block, it would be found to be of deep red. When all symptoms of moisture have disappeared, the fire is covered up, no further fuel is added, and the fire goes out gradually.

The external furnace is pulled down as soon as the bricks have cooled sufficiently to enable the workmen to do so without burning themselves, and in order to hasten the cooling of the block some of the bricks forming the cover of the interior furnace are also removed. Later this is also demolished, and the moulding-block is allowed to cool. In a word, it is necessary to proceed gradually for the process of cooling as well as for that of firing, sudden changes of temperature being fatal, and the success of the operation depending in great part on the regularity of the process.

The firing being now finished, the block has the same appearance as before, only in removing the chimneys the runner and the vent are found to be replaced by holes or channels, while another hole will be found at the base in the place of the wax drain. The wax in melting has formed these channels, and has left a hollow space throughout the block between the core and the mould.

Reference has been made above to the use of iron pins pressed into the wax bust.

As long as the core, the wax, and the mould had not been submitted to the action of the fire they formed a solid mass, but with the melting of the wax the core has become isolated, and, as it is formed of exceedingly friable earth, the least motion might throw it down and break it; this inconvenience is avoided by the employment of the pins above referred to, which, penetrating through the wax, on the one hand into the core, and on the other into the mould, renders the core immovable even after the disappearance of the wax.

7. THE CASTING IN BRONZE.

This is the last operation. The block having become sufficiently cool, it is surrounded with iron frames placed one above the other; the space between the block and the frames is filled by pressing into it ordinary moulding earth. This operation requires the greatest care; its object is to prevent the block from bursting when the liquid bronze is poured into it, by the pressure of the gas and the expansion of the air while the fused metal is flowing through the mould, a comparatively small quantity of metal in fusion being capable of producing effects of incredible force which it is difficult to account for.

The block being perfectly iron bound, a basin of iron covered with baked clay, and pierced with a conical funnel, is placed over the runner and closed with an iron stopper, from which projects a long stem. The hole of the basin communicates directly with that of the runner; the opening of the vent is left free, but in front of it a small basin is hollowed out of the block. Everything is now ready for the casting.

If the bust is calculated to weigh 50 kilog., 80 kilog. of bronze are put into the melting pot in order to be certain of having enough metal, and it is necessary to allow for the runner, the vent, and the drain. The bronze which has hitherto given the best results is composed as follows: 70 kilog. red copper, 28 kilog. zinc, 2 kilog. tin.

The bronze being sufficiently melted, the crucibles are lifted out of the furnace, and are emptied into the basin above referred to; a workman at the word of command takes out the iron stopper, the molten bronze flows into the runner, penetrates into the mould, fills up all the hollows, and returns to its level, the surplus metal flowing out at the vent into the basin that has been hollowed out of the block to receive it, preceded by the air and gas driven out by the entry of the metal.

If the operation has been made without producing noise, the casting may be considered to have been successful, but notwithstanding all the care taken to attain success, some fault may have occurred.

The natural curiosity to learn the result may soon be satisfied, for in a quarter of an hour the metal will have cooled sufficiently to allow the block to be broken up.

The workmen begin by lifting off the iron frames, and then removing the earth that was pressed round it, commence to break up the block with iron picks, proceeding with precaution, and as soon as any portion of the bronze shows itself the picks are laid aside for smaller and lighter tools, with which the "potin" that surrounds and conceals the work is at length removed, the bust gradually appears, and it is possible to judge whether the casting has been successful; the bust itself, however, is covered with a white crust from the "potin" still adhering to it, and which only partially detaches itself. To get rid of this crust entirely is a work of some time.

The runner, the vent, and the drain, which have been transformed by the casting into solid bronze, are now sawed off, the core inside the bust is broken up, and the bust is emptied; it is then placed for several hours in a bath of water and sulphuric acid, and when taken out is vigorously scrubbed with hard brushes, rinsed in clean water, and allowed to dry. The bust is now handed over to the chasers, who efface the traces left by the runners and vents, remove any portions of metal that may fill up the cavities into which the "potin" has not penetrated, stop up with bronze the little holes left by the iron pins, and in fact the work in a perfect state, leaving, however, untouched the epidermis of the bronze, for in this consists the merit and value of the "cire perdue" process, which renders so completely every touch of the artist that it seems as if he had kneaded and worked the bronze with his fingers.

The bust, now completed, is placed in the hands of the bronze decorators, who give it a "patina" in imitation of that produced by oxidation. The color generally preferred for portrait busts is the brown tone of the Florentine bronzes. This artificial "patina" can be produced in a great variety of tones, light or dark, but in every case it is preferable that a well-modeled work should have a dead, unpolished surface.

The decoration of a bronze work is a question of taste or fashion for which there is no rule, though no doubt for many the success of a work depends very often on its decoration.—*The Architect.*

INTENSIFICATION OF GELATINE NEGATIVES WITH SILVER.

THAT not a few of the votaries of the art would forsake mecurial intensification for silver and iron or other permanent redevelopment, were they assured of the absence of abnormal or other stains, may be taken for granted. With the permission of the editors, I shall lay before the readers of the *Journal* a method of intensifying gelatine negatives with silver and iron which has rendered good service since the summer of 1880. I mention the date simply to show that it has stood the test of experience.

The chemicals necessary are identical with those used with wet collodion, with the exception of the chloro-iodo bath, which apparently decomposes the active principle or constituent in the gelatine that causes the well-known pink fog. Neither iodine nor chloride of sodium by itself will prevent the pink stain, but a combination of both as prescribed. The image is, probably, converted into iodide of silver, which in turn gives place, to some extent, to the excess of chloride, forming both iodide and chloride of silver in the film, and during the decomposition the fog-producer is destroyed or rendered harmless. At all events, the negative is very readily and successfully intensified after its immersion in the bath.

The following are the requisite solutions: A, saturated solution of common salt; B, ruby solution of iodine in iodide of potassium; C, ten-grain solution of protosulphate of iron; D, fifteen-grain solution of nitrate of silver; E, a very weak solution of cyanide of potassium.

When the crystals in solution D are dissolved, a few drops of a saturated solution of carbonate of soda should be added, and the bottle placed in the light until clear. The silver should then be filtered and acidified with acetic acid (eschew nitric) enough to turn litmus paper red. To solution C half an ounce of glacial acetic acid must be added to every fifteen ounces of water. Test a mixture of C and D thus: Pour into a developing cup half an ounce of C, and add (say) half a drachm of D. If the combination turn muddy in less than five minutes, add more acetic acid to the stock bottle C, until it remains clear when mixed with the silver solution for the specified time.

To intensify the negative: It is premised that the negative has been "alumed" and washed thoroughly to free it from the fixing agent. If the film be tender it is best, in the first place, to dry it. Now pour into a clean measure sufficient of A to cover the plate; then add a few drops of B, until the color of amber be attained. Immediately place the negative in a clean tray and pour over it the chloro-iodo solution. Leave the plate in this bath for four or five minutes—the thicker the film the longer it should remain—then well wash it under the tap. As vegetable and other extraneous substances from the washing-water often adhere tenaciously to the surface of the film, thereby causing irregular markings, at this stage any such should be gently removed by a tuft of cotton wool dipped in water.

The next operation must be done in the dark room—one in which wet collodion can be worked—or by candle or gaslight. To proceed: into a developing cup shake a few drops of D, and add (say) for a half-plate almost half an ounce of C. Flow this on the negative and let it remain for three or four minutes—not longer—gently rocking the plate the while; then quickly place it under the tap until all greasy lines have disappeared. It will now be seen that a considerable increase of density is the result. One operation generally suffices; but if the image be still too thin clean out the cup and repeat the dose. The plate will be thin, indeed, if it requires a third application. After a good wash, place the negative in solution E for one or two minutes, when it may be examined in daylight. Well wash again, then dry, and varnish.

If ordinary precautions be taken with the above method, there will be little fear of red fog; but if, from inadvertence or other cause, it should appear, immediately immerse the negative in a fresh solution of A and B. It has the valuable property to a great degree of clearing off the stain. Should the fog be deep and obstinate, place *out of doors* the plate in a solution of potassium sulphide, when it (the stain) will gradually vanish. This treatment intensifies the negative. It simply requires to be well washed in running water, dried, and varnished.—*A. Donald, in British Jour. of Photo.*

EGROT'S DISTILLING APPARATUS.

THE continuous distilling apparatus of Mr. Egrot's invention are especially applicable to fermented liquids, molasses, and wines. In devising them, the inventor's object has been to reduce the dimensions of the distilling column, and principally the height thereof, which, in ordinary apparatus, is considerable.

The result is a diminution in the purchase price, and in the cost of installation and carriage. Such a result has been obtained by increasing the length of the liquid's circulation in each shelf and by diminishing the number of shelves. In fact, there are but four or five of the latter in Egrot's column, while there are 18 in those of Dubrunfant and Champonnois, and as many as 32 in that of Savalle. From this diminution in the number of shelves or trays results a diminution of pressure in the column, and, consequently, more regularity in the work, a better product, and less priming. At the same time, the total surface being less, the external cooling is not so great.

The Egrot distilling apparatus (Fig. 1) consists of an alembic, of a wine heater, and of a condenser. The alembic, M, is of small dimension as compared with the column which it serves to support. The distilling column, which is in five parts, supports another column of smaller diameter, which contains a certain number of rectifying shelves.

The wine heater and the condenser, which are both cylindrical, are traversed by a worm that terminates at the test apparatus. Fig. 2 gives the details of the arrangement of a

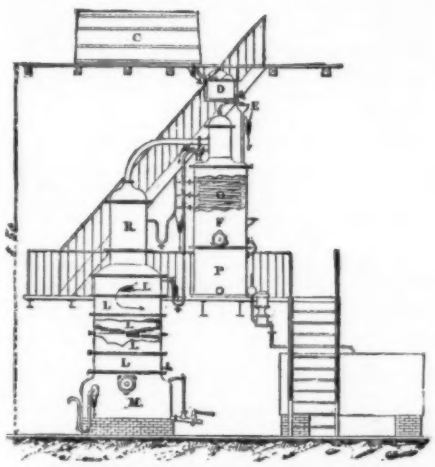


FIG. 1.—EGROT'S STATIONARY STILL.

shelf, and shows the course taken by the liquid, which, after entering at A, from the upper shelf, traverses four concentric rings arranged one under another, and makes its exit at E, in the center of the shelf, which latter is also the lowest point of its travel. From thence, a bent tube leads it to the point, A, of the lower shelf. The apparatus, in another form, when mounted upon two wheels and drawn by a horse, is very transportable, and is capable of being set in operation immediately upon reaching its destination.

Each shelf or disk is provided with quite a number of tubes, *m*, of small dimensions, which allow the alcoholic vapor coming from the alembic to bubble up through the liquid and thus have numerous points of contact therewith. This arrangement likewise allows the liquid to travel a considerable distance within a very short time. The apparatus represented (Fig. 1) is capable of treating 110 gallons per 24 hours.

It is easy to see how the still works. From the reservoir, C, the wine is introduced steadily into the wine heater, F, through the intermedium of the regulating cistern, D, where its level is kept constant. There is thus obtained a uniform discharge from the cock, E. The wine gradually rises in the heater, F, and becomes heated in contact with the worm, G, in which the alcoholic vapors are condensing. It afterward enters the distilling column, L, through the tube, H, and descends from shelf to shelf, and, in doing so, becomes deprived of more and more of its alcohol by contact with the vapor that is rising in the column. When the wine reaches the alembic it is entirely freed from alcohol, and the *vinasse* that continuously flows through the siphon, S, contains not a trace thereof. The alcoholic vapor follows an opposite direction. From the alembic, M (heat by steam or otherwise), it rises and traverses each shelf, and becomes richer and richer in contact with the richer wine that it meets at every moment.

It afterward traverses the rectifying column, R, which contains a certain number of shelves, and is then led by a swan-neck to the wine heater, where it is analyzed. The liquefied portions return to the column and the others condense in the cooler, P, and when they make their exit from the latter they go to the test-tube.

There are fourteen sizes of these stills, that range in capacity from 88 to 220 gallons per 24 hours. The size shown in Fig. 3 is the smallest. It is mounted upon a boiler-plate furnace and upon an iron support.

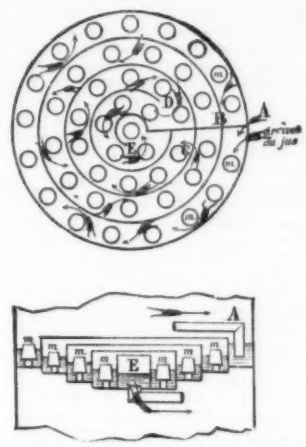


FIG. 2.—PLAN AND SECTION OF ONE OF THE RECTIFYING SHELVES.

In certain cases, Mr. Egrot adds to his apparatus certain accessory arrangements for special purposes. Thus, in order to permit of the production of alcohols of a higher proof than those afforded by ordinary apparatus, he adds a rectifying head, which will give an alcohol exceeding 85°.

For the manufacture of cordials, the alcoholic vapors, before entering the condenser, are introduced into a special receptacle called an "anising box," in which are arranged the aromatic materials, such as anise, absinthe, juniper, etc.

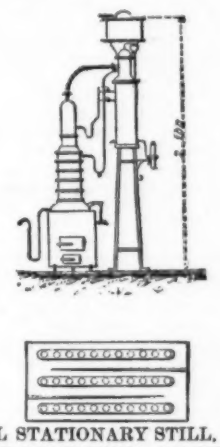


FIG. 3.—SMALL STATIONARY STILL, AND ONE OF THE RECTIFYING SHELVES.

Fig. 4 represents a portable still capable of operating upon 1,760 gallons of fermented liquid per 24 hours. The wine is raised by a hand-pump, C, into the upper reservoir, D, whence it enters the wine-heater and begins to heat therein in contact with the alcoholic vapor. It passes from thence into the rectifier, B, and, through the pipe, L, into the distilling column, which is here rectangular. The structure is the same as that of the stationary column, and the wine circulates therein in an analogous manner.—*Le Génie Civil.*

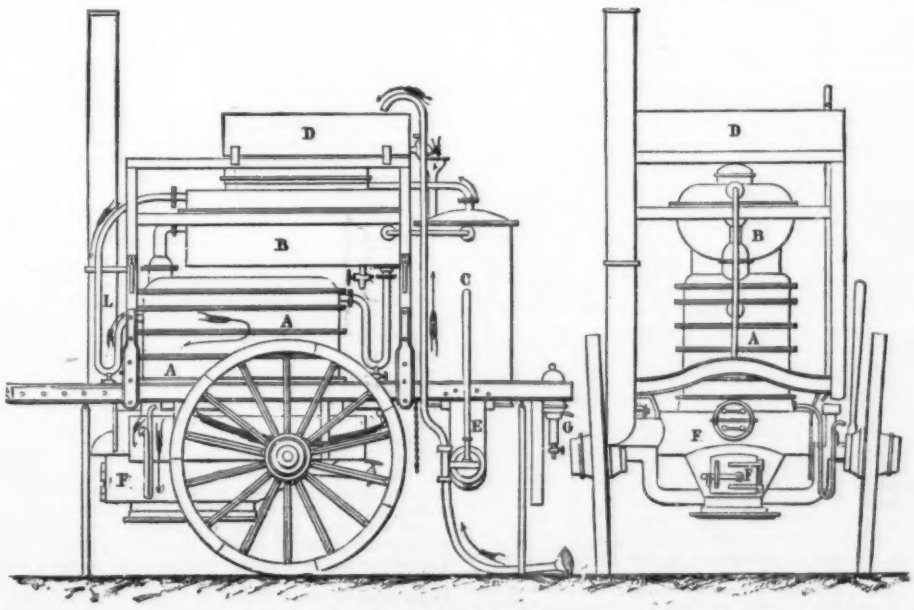


FIG. 4.—EGROT'S PORTABLE STILL.

CARBONATE OF POTASH.

IN this article we shall treat of the methods of procuring the vegetable fixed alkali, and the different forms under which it appears in commerce and domestic use, reserving for future notice the preparation and characters of that neutral salt properly called, according to modern chemical nomenclature, carbonate of potash.

The vegetable fixed alkali was so named by the chemists of the last and former ages because it was produced in large quantities from vegetable substances, and was in no case supposed to be of mineral origin. From certain analyses, however, by Klaproth and other able chemists, it has been discovered to enter, as an essential ingredient, into the composition of leucite, lepidolite and a few other minerals, which are by none suspected of deriving their origin from organized bodies. But though the existence of potash in a mineral state has been thus demostrated, yet it is so small in quantity and so difficultly procurable, that all the vast supplies of this substance which civilized life requires have as yet been entirely obtained from the combustion of vegetables.

If the woody or annual stems of vegetables, that have grown in foils unimpregnated with common salt, after being sufficiently dried are set fire to, the watery, the resinous, the oily, the acid, and carbonaceous portions are volatilized and dissipated in a state of more or less complete decomposition, and there remains behind a reddish or whitish powder, called ash or ashes; consisting chiefly of the earthy and metallic ingredients of the vegetables, together with a variable proportion of subcarbonate of potash. By lixiviation with hot or cold water the alkaline part is dissolved out, and this solution when boiled to dryness leaves behind a dark brown saline mass, consisting of the carbonated potash, colored by a small portion of vegetable inflammable matter; and in this state it is known in the market by the name of potash. Calcination at a moderate red heat completely burns off the coloring particles, and the salt becomes of a spongy texture and beautiful bluish white tinge, and is then called pearlash. Such is in general the process by which the vegetable fixed alkali is separated from the substances with which it is combined by nature, and prepared for use. We shall now proceed to describe more at large the different methods of extracting this salt, together with the precautions that are necessary to secure the greatest success.

The simplest and rudest preparation of potash is called ash balls in England, and weed-ash in Ireland. It cannot be said properly speaking to be an article of commerce, although a considerable quantity is annually made by the peasantry of both countries, and disposed of among the neighboring farmers and bleachers. The vegetable from which this impure alkali is produced is the common fern or brakes (*Pteris aquilina*). Many rough and heathy districts are entirely covered with this plant, which when it has attained its full growth (which happens about the middle of July) is cut down, and after being half dried in the open air, is gathered into small heaps and kindled. The combustion proceeds slowly, being accompanied by a smothering smoke and little or no flame, till the whole is reduced to a reddish, gray ash; this being carefully collected is sprinkled with a little water, and then moulded by hand into balls from three to four inches in diameter, which, when they have acquired a certain hardness and solidity by drying in the sun, are ready for sale. In Ireland, thistles, docks, and weeds of all kind are mixed with the fern, and the ashes are disposed of in their loose pulverulent state without any preparation. According to Dr. Home, fern ashes contain about one-ninth of their weight of salt, consisting principally of subcarbonate and sulphate of potash; 1,000 parts of the plant cut in August, and thoroughly dried, afford 36·46 of ashes, from which are obtained by lixiviation 4·25 of salt. The common Irish weed ashes have been analyzed by Mr. Kirwan, and when deprived of their water by a red heat appear to contain one part of salt for 3½ parts of ash; of this the free alkaline portion, however, as deduced from the quantity, of alum decomposed by the lixivium, amounted only to $\frac{1}{12}$ of the whole.

The potash of commerce, or black potash, as it is also called, is universally procured from the combustion of wood, and therefore its preparation can only be undertaken with success in those uncleared countries in which are vast natural forests, and where from the badness of roads, and imperfection of water communication, the value of timber is no more than that of the labor employed in felling it. The only districts in Europe in which any considerable quantity of potash is made are the mountainous forests of Germany and the extensive woodland tracts of Poland and Russia.

The most wastful method of manufacturing potash is that practiced in America, principally because this employment is carried on rather as subsidiary to clearing the ground for agriculture than on its own account. The wood as soon as it is sufficiently dry to burn is collected into large piles, and reduced to ashes; these ashes are then put into a wooden cistern with a plug at the bottom of one of the sides, and a quantity of water sufficient to make a strong lixivium is added; after standing for an hour or two the plug is withdrawn, and the water holding the potash in solution runs clear out, leaving the earthy part still impregnated with alkali in the cistern. This solution is then evaporated to dryness in iron pans, and hastily fused into compact reddish-brown masses of semi-caustic potash, in which state it is fit for the market.

In Germany, where potash is prepared on its own account, and where a greater degree of intelligence and economy is practiced, the general method of proceeding is the same as that just mentioned, but with such varintions as, though seemingly of little consequence, materially augment the product of alkali. Care is taken to select such kinds of wood as are the richest in potash; the combustion is slower, and of course the temperature lower, in consequence of which but little is lost by volatilization; the lixiviations of the ashes are also judiciously repeated till the whole of the alkali is extracted.

The common Russian potash is the impurest of all, containing nearly one-half its weight of earth, and is thus prepared: A large pit is dug, into which are thrown burning brands, and the smaller extremities of the branches, and when the whole is well kindled the pit is filled up with logs and other large pieces, which at length, though very slowly, are reduced to ashes. The coarser part of the ashes is then separated by sifting from the finer; all the alkali that it contains is procured by lixivation; and this liquor is mixed with the remainder of the ashes and worked together into a kind of paste. A pile is then built of alternate strata of wood and this paste, and being set fire to, the whole is again reduced to ashes. This process is repeated several times till the ashes begin to clot and become hard; the most compact pieces being then selected, are packed up for sale without any further preparation; the rest are lixiviated and boiled down to dryness in the usual manner.

In some parts of Germany potash is made from the empyreumatic acid produced from wood while burning into

charcoal. By means of wide tubes of plate iron or copper, the acid and oil which would otherwise be dissipated in the air are collected; the watery acid part being then separated from the other is evaporated to dryness, and the residuum by calcination affords an ash extremely rich in alkali.

Potash is converted into a much purer alkaline salt called pearlash, by calcination; for this purpose the potash broken into moderately small pieces, is spread on the floor of a reverberatory furnace, and being then kept red hot, but not melted, for an hour or two, stirring it occasionally with an iron rake, all the carbonaceous and coloring particles are burned out, and there remains behind a dry, porous, and considerably caustic salt extremely deliquescent, and from its bluish-white color called pearlash.

The uses of potash are innumerable. It is consumed in large quantities by the glass maker, soapboiler, and bleacher, and in the laboratory it is in constant and indispensable service.—*Glassware Reporter.*

LINSEED—ITS BOTANY AND CHEMISTRY.*

By E. H. EARLE.

THE plant known from the value of its products in manufactures and the arts as *Linum usitatissimum* is an upright annual having a height of from one to two feet. The stem is smooth and green, and the leaves are linear lanceolate, alternate, and sessile. The calyx consists of five sepals, which are ovate and acute, and have membranous margins. The corolla consists of five petals, which are of much larger size than the sepals. They are somewhat crenated and are caducous. These petals are of a conspicuous purplish blue color. Both stamens and styles are five in number. The fruit is a capsule, which dehisces septicidally; the carpels being divided from each other, and these again partially divided down the partition between each pair of seeds.

The native country of the flax plant is unknown, but central Asia has been mentioned as the probable source.

The plant is reared in this country in Lincolnshire, Cambridge, Suffolk, Devon, and Somersetshire. The seeds obtained from the two latter counties are held in highest esteem. In India the flax plant has been under cultivation for centuries for the seeds, whereas in Europe the fiber of the plant was more developed, as linen and not oil was desired.

Experiments have lately been made in India with Dutch and American seed, with a view to cultivating a good flax-yielding plant, but they have not as yet been very successful. This is said to be owing to insufficient moisture in the soil. The seeds are sown in the autumn. India also imports much European grown seed for the extraction of the oil, which possesses more satisfactory drying properties than that obtained from native grown seed. At least such is stated to be the case.

Flax being the more important of the products of this plant, I will allude to it first.

Flax has been known from the earliest ages. It constituted a field crop at the period when the Israelites were in Egypt, and the fibers were used for the manufacture of garments. Herodotus mentions this fabric as constituting articles of clothing among the Egyptians, upon whose monuments and tombs the processes which the fiber underwent for economic purposes are depicted with great accuracy. The clothes in which the mummies are wrapped are found to consist of linen, but of a very coarse texture. It was also used for filtering wine through, and a very rough or strong quality formed sails for boats, according to classical writers.

The Romans seemed to prefer wool to linen in the way of clothing. The emperor Alexander Severus is reported to have been the first Roman who had the courage to wear a linen shirt. After the fall of the Roman Empire flax-weaving was lost sight of until the tenth century, when it was started at Ypres in Flanders, and was from that time carried on in various parts of the Continent with varying success, I believe the celebrated Bayeux tapestry is worked on linen.

The seeds from which the flax plant is to be reared should be plump, heavy, and shining; and should be freed from impurities by sifting.

The soil answering best for its cultivation is a dry loam, and in good flax-growing soils silica is found to the amount of 60 per cent. or, in some cases, 80 per cent. Flax has always been notorious for exhausting in a high degree the soil from which it is raised. In the Georgics, Virgil speaks of it as "scorching the fields." This was owing in a great measure to the cultivators not understanding the rotation of crops. Thus many districts are barren in Sicily and Asia Minor—once the granary of Rome—Spain, and the Campania, which were historically fruitful.

Irish-grown flax is considered the best for the manufacture of linen, and there the crops are rotated so as to allow of an interval of about six years before again using the soil for flax. The first year grass is grown; in the second year oats; in the third year potatoes or turnips; in the fourth year wheat; in the fifth year flax, clover, or beans. In this way the soil suffers no harm.

In order to obtain a superior fiber for linen manufacture, the plant is gathered before it reaches maturity, which is indicated by the partial change of the green stem to yellow, and of the green capsule to brown.

The stem consists essentially of a woody interior, and externally of the fiber needed for flax.

The plant is gathered and dragged through a rough comb, which separates the capsules. This is known as "rippling" it. It is next "retted," which operation consists in steeping it in soft water for about a fortnight, in order to dissolve out the gummy and resinous matters holding the woody and fibrous portions together. Ponds have to be dug out for the purpose of steeping the flax, as the plant renders the water so offensive that cattle drinking at a river or stream in which the operation had been conducted would be poisoned. In the reign of King Henry VIII. an act was passed forbidding the pollution of river water by such means.

In Sweden the plant is boiled in sea water, together with lime and birchwood ashes, and finally washed with soap. This operation ended, it is "grassed," or laid out for sun bleaching, being turned once or twice in order that all parts may experience the same influence. This occupies about a fortnight. It is then tied in sheaves or bundles and sun dried. It is often broken or "scutched" before being sent into the market. This process consists in beating with mallets or flails until the adhering wooden portion is well broken up. This is now chiefly done by machinery. It undergoes in the mills many processes which are too intricate to be followed out in a paper of this nature, besides involving some technical education. After being "combed" or "heckled" in the mill in order to separate the fibers, flax presents long glistening silver gray or yellowish fibers resembling silk when viewed from a short distance. The fibers broken off short in combing constitute tow.

Flax is also imported from the Baltic ports, Holland, and Belgium.

Scraped linen constitutes lint. There has been some discussion from time to time as to the superiorty of lint over cotton in bandages. Cotton is more irritating, and this is said to be due to the cells, of which it is composed, being flat and having sharp edges, or by these flat cells twisting when wetted, in both cases proving uncomfortable to the patient. Flax cells, however, are cylindrical, and thus, having no sharp edges, are superior for dressings.

The seeds now come under our notice. They are small, brown, and glistening; oval in shape and having sharp edges. They are official, being used for the infusion of linseed. They are used for food in some parts of Russia and Abyssinia.

The seed coats contain a mucilage, according to some writers, which exists in the *growing* plant as *starch*. The nucleus contains much fixed oil (about one-third the weight of the seed). It is when first expressed of a pale color, but darkens on keeping. It consists chiefly of glycerides, together with fatty acids—notably, linoleic—to which the drying properties are due.

The seeds are obtained from St. Petersburg, Riga, Libau, and other Baltic ports both in Russia and Germany, the Black Sea ports, Bombay, Calcutta, Italy, New York, and La Plata in South America. The Baltic supplies the greatest amount, and the La Plata seeds go chiefly to the Continent.

Linseed meal is officially directed to be obtained by powdering the cake from which the oil has been expressed. It is used as a poultice, which is often stated to have irritating instead of soothing effects. This may be due to the admixture of cruciferous seeds, such as rape and mustard. As the irritation was supposed to arise from the natural oil of the linseed becoming rancid, the meal is directed to be obtained—as stated before—from the cake and not from the seeds. Olive oil is directed to be added when a poultice is required in order to replace the natural oil, which to say the least is an inconvenient arrangement.

Taking now the expression of the oil from the seeds as actually carried on: The seeds are stored by means of an elevator at the top of the warehouse, and by means of a long wooden tube a stream of this seed is poured into a large wooden box, which allows a regulated amount to pass in a continual stream between two almost solid steel rollers about 18 inches in diameter, and on emerging from between these the seed falls upon a sloping iron ledge which directs the steam between two more rollers, and so on, until by a course shifting from one side to the other, the seeds emerge finely ground, and constituting a true linseed meal.

The temperature of the room is about 90°, so that a more plentiful supply of oil should be yielded.

Machinery now carries the meal into a large tub-like arrangement known as the "kettle." A workman below waits with iron trays upon which are coarse cloths. These trays are about a yard long and a foot wide.

These trays are placed below the "kettle," from which, by means of a trap, a requisite amount of meal is deposited upon the cloth-covered tray. The meal is pressed just sufficiently to cause it to adhere together, and it is then covered at the top by the ends of the cloth before mentioned, and the tray is then placed in a press by another workman, who accumulates a pile of about a dozen in a press in about ten minutes.

At the bottom of this pile of trays is a solid steel slab, which now ascends and presses the cakes against the top of the press. The oil flows very freely into tanks below, which have only one small hole for the oil to run out of. This prevents a too rapid current, which would carry mucilage and other matter along with the oil, which runs through a series of tanks, always depositing until it reaches the large storage tanks, from which casks are filled for sale or export.

The press being loosened again, the trays are removed, and the cake, now apparently quite dry, is divested of the cloth which was used to allow of the cake being more easily removed from the trays, and the edges neatly beveled by means of a sharp knife running in a groove, which cuts the cake to the required shape and size.

The portions of cake trimmed off are ground up and worked over again.

These cakes weigh about 12 pounds and contain mucilage, phosphates, and nitrogenous matter, and about 4 per cent. of oil, which renders them of great service in cattle feeding.

The seeds I saw worked were Calcutta seeds, and appeared remarkably free from admixture. Thirty-three per cent. of oil was extracted and 4 per cent. left in the cake, so these seeds yielded very good results.

Linseed oil may be divided into four kinds—raw, refined, boiled, and artist's.

Raw oil is obtained in the manner just described.

Refined oil is raw oil allowed to stand for weeks or even months, to allow impurities to settle, and then is treated with litharge or acetate of lead either when hot or cold. It is also sometimes heated with sulphate of zinc or alum, which is said to hasten the deposit of impurities. The lead is often separated with oil of vitriol, and this bleaches the oil and also converts any lead into sulphate, which might, when mixed with paint as white lead, be converted otherwise into yellow oxide when exposed to air.

Boiled Oil.—Here the oil is boiled for about five hours, and then driers are gradually added in the proportion of 5 pounds to a ton of oil. The whole is then boiled for an hour. After this the oil is left by some manufacturers until a pellicle forms, when the oil is then run off or ladled out. Some manufacturers allow it to stand for weeks until all the driers have settled and the oil is clear and bright. The sediment and scum are used in putty. It is tested by dipping sized paper into the oil and seeing if a varnish is formed, on drying, over the *whole* of the paper. If only the bottom of the paper is varnished, while the top remains greasy, the oil is insufficiently boiled. The drying into a resin or varnish is seen to be due to the absorption from the air by oxygen, by spreading the oil over zinc plates and weighing. When a varnish is formed, the weight of the oil is found to have increased by nearly one-half.

Boiling oil was almost a traditional arrangement for promoting its drying; but black oxide of manganese and red lead were added with the idea of giving to the oil at a high temperature that amount of oxygen requisite to aid its commencement in absorbing oxygen from the air. The black oxide is said to part with oxygen, which it again absorbs on being stirred to the surface, over which a current of air is passing. Borate of manganese is also used. The pans in which the boiling takes place are of copper or iron, with an iron jacket, and are heated by steam. They have a dome cover from which two fans or stirrers are arranged to stir up the oil. From the dome the irritating vapors of acrolein are conducted into bottles of water.

Lastly comes artist's oil. There are several kinds, which are made to suit private forms, and consist chiefly of heating the oil with acetate of lead and litharge, and bleaching with ferrous sulphate or by exposure to sunlight.

The foregoing paper was followed by one on—

THE CHEMISTRY OF LINSEED.

By EDW. CULLINAN, JR.

THE chemistry connected with linseed and its products is not only very interesting, but has received some very important technical applications.

Composition of the Seeds.—The testa contains an abundant secretion of mucilage; the cotyledons, a fixed oil. The average composition of linseed, as analyzed by Dr. T. Anderson, shows the following results:

Albuminous substances	24·24	parts in 100.
Oil	34·00	
Gum, sugar, and cellulose	30·73	
Ash	3·33	
Water	7·50	

A more complete analysis of the seeds by Meyer gave the following results:

Fat oil	11·265	parts in 100.
Wax oil	0·146	
Acrid soft resin	2·488	
Resinous coloring matter	0·550	
Yellow extractive and tannin	1 917	
Sweet extractive, malic acid, and salts	10·884	
Gum	6·154	
Nitrogenous mucilage, acetic acid, and salts	15·120	
Starch	1·480	
Albumen	2·782	
Gluten	2·932	
Husk	44·382	

The seeds are principally cultivated for the oil, but linseed cake, *i. e.*, the marc left after the expression of the oil, is also a valuable substance for feeding cattle. According to Voelcker's analysis,* it contains:

Oil	10·90	parts in 100.
Albuminous substances	24·56	
Mucilage, starch, and digestible fiber	31·97	
Woody fiber	11·47	
Ash	6·20	
Moisture	14·90	

The proximate substances contained in the seeds may be conveniently divided into four: (1) mucilage, (2) albumen, (3) sugar, (4) fixed oil. Of these only Nos. 1 and 4 will be considered now.

Mucilage.—This is a universal constituent of plants, although found in some under different modifications. According to Thomé, linseed mucilage is formed by the conversion of the epidermal cells into mucilage by the excessive thickening of the cell wall; the innermost layers under the influence of water swell to an extraordinary extent and burst the outer layers, emerging from them as a transparent mucilage. It may, therefore, be considered as a product of the transformation of the cell-wall. It is contained in the testa of the seeds. It may be obtained from them by boiling with water (by which means it will be obtained in thick threads) or by shaking the seeds with acidulated water, filtering, heating to coagulate albumen, concentrating, and precipitating with alcohol. It is less transparent and brittle than ordinary gum, insoluble in cold water or alcohol. In a dry state it contains about 10 per cent. of mineral substances, but if freed from these and dried at 110° C. it yields a formula corresponding to $C_{12}H_{20}O_{10}$ (similar to althæa mucilage. With boiling nitric acid it gives crystals of mucic acid. The mineral constituents contained in it are chiefly phosphates of potassium, magnesium, and calcium. The seeds yield about 15 per cent. of mucilage. It is a most useful material for luting stoppers and other such joints in glass works.

Fixed Oil.—This is obtained from the seeds with or without the aid of heat. Preliminary to pressing, the seeds are crushed to a fine meal. For the finest quality of cold-drawn oil this meal is inclosed in horse hair envelopes, and pressed either by means of wedges, in a screw press, or in a special form of hydraulic press. The cake left may then be submitted to heat and again pressed. Practically, cold drawn oil is seldom prepared, but after the seeds have been ground they are roasted (to destroy mucilage) and the oil expressed. The yield of oil is from 28 to 33 per cent. According to Mr. E. Woolsey, the quantity of oil varies according to the weight, quality, and kind of seed used, and his experiments show that the quantity of oil extracted is from thirteen to twenty gallons per quarter, and that the seed known in commerce as "Best Odessa" yields the most oil. Ladureau states that Russian linseed grown in France becomes valueless after the second generation, and the ash is found to lose more than half its phosphates (*Chem. Soc. Journ.*, 1880). Elaborate descriptions of the machinery employed for extracting the oil may be found in Ure's "Dictionary of Arts."

When expressed without heat, linseed oil presents very little color and no unpleasant taste, but the commercial oils are usually dark yellow, with a peculiar taste and odor. According to Sassure's analyses, it contains:

Carbon	75·17	parts in 100.
Hydrogen	10·98	
Oxygen	13·85	

corresponding to the formula $C_{18}H_{32}O_2$. Chemically it is a glyceride of linoleic acid. By saponification it yields glycerin and fatty acids, oleic, palmitic (Schuler), myristic, and linoleic. If boiled for some time it loses weight, becomes thick, and dries up readily to a solid transparent varnish, called linoxyn ($C_{72}H_{94}O_{22}$). Heated to 323° C. it takes fire and leaves tar and charcoal, but if interrupted by closing the vessel, a brown turpentine body will be left, similar to birdlime. Bromine and chlorine will combine with the oil at a temperature of 50° to 80° C., yielding dark brown liquids, known as brominated and chlorinated linseed oils, and having the formulæ represented by $C_{18}Br_2H_{32}O_2$ and $C_{18}H_{32}Cl_2O_2$. With H_2SO_4 (specific gravity 1·478) it is turned green; with strong sulphuric acid it is turned yellow-brown, coagulated, and at last formed into a tough, ropy mass, which, mixed with water or spirit, has been used for precipitating gelatin under the name of "Hatchett's artificial tannin." Exposed to the air it absorbs oxygen and forms a resinous mass called oxylinoleic acid ($C_{18}H_{32}O_3$), and this takes place much more rapidly if the oil be heated. In combining with oxygen it evolves much heat, and has been known to cause

* Recent papers read before the School of Pharmacy Students' Association, London.

* *Journal Royal Agricultural Society*, 2d series, vol. xvi., p. 699.

the inflammation of cotton waste. It is soluble in 5 parts of boiling water, 32 parts of alcohol, and 1·6 parts of ether, and it will dissolve sulphur, selenium, arsenic, and phosphorus. Sulphur dissolved in four times its weight of oil forms a brown viscid mass, known as "fatty balsam of sulphur." A solution (6 in 1) is contained in the non-official formulary of the Dutch Society for the Advancement of Pharmacy (*New Remedies*, 1889). Boiled with dilute nitric acid it becomes thick and hardens in the air to a substance possessing the property of softening in warm water and resembling caoutchouc.

The oil obtained from linseed belongs to that class known as "drying," and these are of sufficient importance to warrant our consideration.

Drying Oils.—This is a division of fixed oils, which, when exposed to air, absorb oxygen and ultimately become converted into a yellowish supple varnish. They contain a glyceride different from non-drying oils, and yield by saponification, linoleic or some similar acid. It is probable that they contain a glyceride of linoleic acid, stearin and palmatin, by the varying proportions of which their differences are determined. They are not solidified by treatment with nitrous acid and mercuric nitrate, and they are distinctly heavier than non drying oils.

The following is a list of the principal drying oils, together with specific gravities and solidifying points:

Cress seed oil.....	Lepidum sativum...	0·924–15° C.
Deadly nightshade	Atropa Belladonna..	0·925–27° C.
Gourd seed	Cucurbita Pepo.....	0·9231–15° C.
Grape seed.....	Vitis vinifera.....	0·9202–11° C.
Hemp seed.....	Cannabis sativa....0·93075–27·5° C.	
Linseed.....	Linum usitatissimum	0·935–20° C.
Poppy seed.....	Papaver somniferum	0·927–18° C.
Sunflower seed....	Helcanthus annuus.	0·925–16° C.
Scotch fir	Pinus sylvestris. ...	0·931–30° C.
Tobacco seed.....	Nicotiana tabacum.	0·923–15° C.
Walnut seed.....	Juglans regia.....	0·928–18° C.

Those in common use are linseed and nut, hemp, and poppy seed oils.

Linoleic Acid.—This acid belongs to the $C_nH_{2n-4}O_2$ group. Its formula is $C_{16}H_{28}O_2$ or $C_{15}H_{27}COOH$. It occurs in linseed and poppy seed oils, and probably in all drying oils. It may be prepared from linseed oil by saponifying, purifying the soap by salting out, dissolving in excess of water, and then throwing down by excess of calcium chloride. The precipitate, which is linoleate of calcium, is washed, pressed, and digested in ether, which dissolves it. The ethereal solution is decomposed by hydrochloric acid, linoleic acid being formed, which is soluble in the ether. The ether is then distilled at a low temperature in a stream of hydrogen, leaving impure linoleic acid. It may be purified by dissolving in alcohol, precipitating as a barium salt with ammonium chloride and barium chloride, washing, pressing, and again dissolving in ether. This is then decomposed with hydrochloric acid, the ethereal layer drawn off, redistilled in a current of hydrogen, and finally dried in a vacuum over sulphuric acid.

Mulder estimates it approximately by saponifying, dissolving the mixed fatty acids in alcohol, carefully evaporating, crystallizing out the palmitic and myristic acids, and converting into lead salts. The oleate and linoleate of lead may then be extracted with ether, and the linoleate separated by repeated evaporation in air and resolution in ether (*Amer. Journ. Pharm.* xl., 249).

Linoleic acid is a yellowish limpid liquid, insoluble in water, soluble in ether and alcohol, having a weak acid reaction. On exposure to air it oxidizes to a thick, viscid mass. Its salts are very easily oxidized. Nitrous acid and mercuric nitrate do not form elaidic acid with it. The formula attributed to it is doubtful. If correct, the acid is isomeric with palmitolic and homologous with sorbic ($C_6H_8O_2$) and stearolic ($C_{18}H_{32}O_2$) acids.

Uses of Linseed Oil.—The principal use of the oil is in the preparation of oil paints and varnishes, but it is also used in the preparation of linoleum, oil cloths, printing inks, and gummed silks. For painting and varnishing it is used either as raw or boiled oil. Boiled oil is prepared by boiling the raw oil for two hours, ladling off scum, and then adding a certain proportion of "driers." The substances used for this purpose are kept as trade secrets, but they are generally composed of equal parts of minium and litharge, or a mixture of these with other substances, such as manganese dioxide, lead acetate. Messrs. E. Barruel and Jean recommend that the resinification be effected with manganese borate. After the admixture of "driers" the oil is again boiled for some hours, and after cooling stored in tanks so that the uncombined driers may settle to the bottom. The theory of boiling has been differently explained and is not understood. Liebig suggested that by the process the mucilage and foreign matters were removed; Chevreul, that the chemicals oxidize the oil, and thereby induce a more rapid absorption from the air.

Adulterations of Linseed Oil.—The substances used for this purpose are very numerous. Not alone are the seeds mixed with other kinds before expression, but the oil itself is frequently sophisticated. Nearly all but the very best samples are impure. The principal adulterations are cotton, rape, poppy, and hemp seed oils and resin, mineral and fish oils. These adulterations are very difficult to detect, although the following tests are useful in determining them:

(1) *Density*—The true oil varies from 0·932 to 0·937; boiled oil from 0·940 to 0·941. Mineral and seed oils are lighter, resin oil is heavier. All the samples of commercial oils that I have tested have been lighter, and have varied from 0·930 to 0·931.

(2) *Solidifying Point* of pure oil is —27° C., but samples containing other seed oils freeze at a higher temperature.

(3) *Elaiden Test.*—This consists in treating the oils with nitric acid and copper, or nitrous acid and mercuric nitrate. The non-drying oils are converted into a more or less solid mass of "elaiden." By this means almond, olive, rape, and castor seed oils may be detected. I exhibit a number of different "elaidens" obtained from different oils.

(4) *By passing Chlorine into the Oil.*—If fish oils be present, the color will change from brown to black. Fish oils may also be detected by the action of nitric acid. Ten grammes of the oil suspected to contain fish oil may be treated with 3 grammes of nitric acid, stirred, and left to separate. Pure oil becomes green and then a dirty yellow green, whereas a mixed oil becomes dark brown and even black.

(5) *Flashing Point.*—A mixture of hydrocarbons with linseed oil always diminishes the flashing point. The true flashing point of linseed is 283° C., whereas Mason has found that samples of oil mixed with hydrocarbons present a flashing point as low as 128° C.

(6) *Behavior with* H_2SO_4.—When 50 c. c. are mixed with 10 of strong sulphuric acid, a rise of temperature from 14° to 184° C. takes place, whereas with sunflower, poppy, olive, and almond, the rise in temperature is between 14° to 90° C. (Dragendoff's "Plant Analysis," translated by Greenish).

The principal adulterations of boiled oil are resin and resin oil. Allen states that the latter may be detected by titrating with alcohol and alkali, and extracting with ether. By evaporating to dryness the resin may be extracted and recognized by taste and smell, and even in favorable circumstances presenting the physical characters of resin.

Adulterations of Linseed Cake.—According to Holderfleiss, Ranuard, and Corenwinder (*Jour. Chem. Soc.*, 1882–83), it is largely adulterated with rape cake, hemp and colza seeds, and other seeds belonging to the Cruciferæ. Rape and colza seeds may be detected by Maibho's test. Boil with potassium hydroxide, filter, and test with lead acetate paper. A black color indicates sulphur present in cruciferous seeds. The presence of these seeds, as stated by Greenish and others, is highly injurious in their use in medicine.

Much of my information has been derived from the works of Allen, Gmelin, Watts, and others, and also from original papers by various authors, most of which have been acknowledged when referred to. I am also indebted to and desire to thank Mr. Dunstan for laboratory assistance, Mr. Earle for samples, and Mr. Walker for practical details.

THE LOSS OF NITER IN THE MANUFACTURE OF SULPHURIC ACID.

THE *Journal* of the American Chemical Society quotes from an English source the results of some tests made by Mr. G. Eschellmann, at the Widnes works of Messrs. J. Muspratt & Sons:

The niter used was from 2·75 to 3·24 per cent. of the sulphur. Of the niter used, from 10·7 per cent. to 12·5 per cent. of this was left unabsorbed. The mechanical losses represent 22 per cent., distributed as follows:

		Per cent.
1. At Glover Tower.....		1
2. Gay-Lussac Tower..	*a.* Non-absorption of soluble gas. 12	19
	b. Escape of nitric oxide..... 7	
3. Leakage, etc.....		2

As to chemical losses by reduction of nitrogen oxides, calculation showed that an increase of steam by one-third would only raise the temperature of the first chamber by 2·6 degrees. The variation in temperature due to that of the external air amounted to less than 5 degrees in twenty-four hours. The variation due to potting was found to be from 48 to 68 degrees C., showing lowest when the niter pot was nearly exhausted. A fall in temperature indicates less vitriol made. Loss by reduction results from fall of temperature or excess of water. In an experiment where vitriol with four equivalents of water was made instead of three, the loss by reduction amounted to 10·5 per cent. of the niter. Excess of oxygen caused a loss of sulphur, and a fall of temperature in the chambers. With less than 3 per cent. of oxygen, much extra niter is required. To the above table the author adds 31½ per cent. of loss from steam at the inlets, leaving still over 46 per cent. unaccounted for.

CHLOROPHYL PROBABLY A COMPOUND OF IRON WITH ONE OF THE GLUCOSIDES.

By Dr. A. B. GRIFFITHS, F.C.S., Membre de la Société Chimique de Paris, etc.

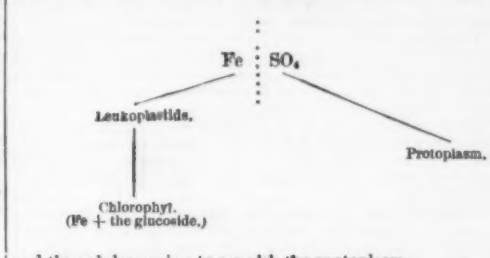
MANY chemists and other scientific men have been working of late on the constitution of the green coloring matter of plants. The latest researches are those of Dr. Edward Schunck, F.R.S. (*Proceedings of the Royal Society*, vol. xxxvi., p. 183). In these interesting researches he shows that most probably chlorophyl is a glucoside. He makes an extract of leaves in boiling alcohol; the extract is allowed to settle, and then filtered; the deposit on the filter is mixed and shaken up with its own volume of ether and with about two volumes of water. The liquid then divides into two strata—the upper green one (*a*), which Dr. Schunck says contains all the chlorophyl, and a lower yellow one, which contains tannic acid, a yellow coloring matter, a substance giving a glucose reaction with Fehling's solution (this glucose, I venture to say, is derived from the protoplasm of the plants, for I have found glucoses* in the protoplasm of living and dead cells of *Spirogyra*). Dr. Schunck now separates the two liquids, and the upper one is shaken up with a fresh quantity of water and ether until the lower layer does not give the glucose reaction. The upper liquid leaves on evaporation a green residue. If this residue be dissolved in alcohol and treated with sulphuric acid, and the alcohol evaporated off, then on adding Fehling's solution the glucose reaction is produced; thus proving that green leaves of all plants contain a glucoside, and that this glucoside, says Dr. Schunck, is very likely chlorophyl.

Now, by taking some of Dr. Schunck's green residue from the upper liquid (*a*), already referred to, dissolved in alcohol, and adding a solution of potassium ferricyanide, a blue color was produced, most probably indicating the presence of iron.

In a previous memoir (*Transactions of the Chemical Society*, 1883, p. 195, and the *Journal of the Royal Microscopical Society*, 1883, p. 536) I have shown the existence of crystals of ferrous sulphate in close proximity to the chlorophyl granules of certain plants. It is most probable that *iron* enters into the constitution of green chlorophyl; perhaps it is a complex molecule of iron and this glucoside of Schunck. We know that no green colored chlorophyl is produced in plants growing in soils, solutions, or other media deprived of iron. Iron, therefore, plays a most important part in the life of all plants; indirectly it is the means of the process of assimilation taking place, and also the manufacture of starch, sugars, gum, cellulose, etc., in the cells of plants.

From my already published researches† on the value of ferrous sulphate as a manure, I may say that the *iron* acts most probably as the food for the chlorophyl granules, and the *sulphur* as the food for the protoplasm of the cells, etc.; for I have grown plants to maturity in a solution containing all the inorganic salts requisite for plant life. But the whole of the sulphur in solution was in the form of sulphate in combination with dyadic iron, and not in combination with calcium or sodium; thus showing that the sulphur of the ferrous sulphate (my new manure) nourishes or acts as a food for the protoplasm or the albuminous parts of the vegetable organism, for I have found that plants will not grow if entirely deprived of sulphur in some form or other.

From my recent work on this subject it is not improbable that in the chlorophyl cells the molecules of ferrous sulphate which are taken up by the roots are constantly being decomposed, the iron combining with the colorless variety of this glucoside, (*i. e.*, the leukoplastids of the vegetable physiologist), forming the green glucoside (chlorophyl):



and the sulphur going to nourish the protoplasm.

Probably this or similar metamorphoses continue throughout the life of the plant, for, as Liebig says:

"Vitality is the power which each organ possesses of constantly reproducing itself, and for this it requires a *supply of substances* which contain the constituent elements of its own substance and are capable of undergoing transformation."—*Chem. News.*

ON THE CONSTITUTION OF CHLOROPHYL.*

By EDWARD SCHUNCK, F.R.S.

AN examination of some products derived from chlorophyl, which has occupied me for some time, has led to the question of the true nature and constitution of chlorophyl, a question on which widely different opinions prevail. Without entering into matters which concern the physiologist only, it may be said that to the chemist chlorophyl is simply an organic coloring matter, the substance to which the green color of leaves and other parts of plants is due. Now, coloring matters are of three kinds.

To the first class belong such as occur ready formed and in a free state in vegetable and animal organisms, such as the coloring matters of turmeric and safflower. The second class comprises those that are formed from colorless chromogens by the combined alkalies and oxygen, the coloring matters of logwood and archil being well known examples of this class.

These coloring matters change rapidly when exposed to the further action of oxygen in the presence of alkali, but are quite stable when in contact with acids. The third class consists of glucosides, bodies which do not undergo any considerable change under the influence of alkalies, but are rapidly decomposed when acted on by acids or ferments, yielding, on the one hand, some kind of glucose, and on the other, substances in which the tinctorial properties of the parent substance are much more pronounced.

To this division belong the coloring matters of madder, quercitron, cochineal, etc. Now, chlorophyl in its general properties so much resembles the members of the last class, that one cannot help suspecting that to this class it may belong—that it is, in fact, a glucoside. It shows considerable stability in the presence of alkalies, but acids decompose it rapidly, giving rise to substances which are intensely colored, and show a power of absorbing particular parts of the spectrum much more strongly than chlorophyl itself. Whether, along with the latter bodies, it yields by decomposition with acids some kind of glucose seemed to me a question worthy of attention.

If it was possible to obtain chlorophyl in a state of purity, it would be very easy to settle this question; unfortunately all attempts hitherto made to separate and purify chlorophyl have ended in its decomposition. I consider it as certain that the so-called crystallized chlorophyl which has been described by several authors is in fact a derivative of chlorophyl formed during the process employed for preparing it.

It is, however, very easy to obtain a solution of chlorophyl which shall be quite free from everything soluble in water extracted at the same time from the plant, and therefore free from ready-formed glucose. In order to effect this I proceed as follows: Having extracted leaves of any kind with boiling alcohol, I allow the extract to stand for some time, filter off the deposit which usually forms, and then mix it with its own volume of ether and with about two volumes of water, shaking up well.

The liquid now separates into two layers, an upper green one, containing all the chlorophyl of the extract, and a lower bright yellow one, which contains tannin, a yellow coloring matter, a substance giving the glucose reaction with Fehling's solution, and probably other substances besides. The two liquids are separated in the usual way, and the upper one is shaken up with fresh water, which now usually only shows a trace of color.

This process of washing may be repeated, adding each time a little fresh ether, until the lower layer ceases to give the glucose reaction. The upper liquid leaves on spontaneous evaporation a bright green residue, which, though far from being pure chlorophyl, is free from everything soluble in water, and may therefore be employed to determine whether anything soluble in water, such as glucose, is formed by the action of acids on it. If some of the residue be treated with concentrated sulphuric acid in the cold it dissolves, forming a green solution, which, after standing for some time, gives, on the addition of water, a dark green precipitate.

This precipitate consists essentially of two substances, the phyllocyanin and phylloxanthin of Frémy, which are undoubtedly products derived from chlorophyl, showing the absorption-bands of what is usually called "acid chlorophyl." The liquid filtered from this precipitate, when mixed with copper sulphate and an excess of caustic alkali, becomes blue, and the mixture, on boiling, deposits cuprous oxide.

The experiment may be made in a slightly different manner. The residue left by the green ethereal solution of chlorophyl having been dissolved in alcohol, sulphuric or hydrochloric acid is added to the solution, which is then boiled for some time, evaporated so far as to drive off most of the alcohol, filtered from the products insoluble in water, made alkaline, then mixed with Fehling's solution and boiled, when the usual glucose reaction takes place. In order to make sure that the reaction was not due to ready-

* "Notes on Loew and Bokorny's Researches on the Probable Aldehydic Nature of Albumin." *Chemical News*, vol. xviii., p. 179; *Journal of the Royal Microscopical Society*, April, 1884, p. 249; *Journal of the Chemical Society*, 1884 (abstracts), p. 202.

† "Experimental Investigations on the Value of Iron Sulphate as a Manure for Certain Crops," *Transactions of the Chemical Society*, 1884, pp. 71–75; and the *Evening Telegraph* of Philadelphia, U. S. A., March 8, 1884.

*A paper read before the Royal Society, Dec. 20, 1883.

formed glucose, I took in every case the precaution of testing a portion of the green chlorophyllic residue with Fehling's solution before acting on the rest with acid. This was easily done by treating with weak alcohol, to which a little alcoholic potash and some Fehling's solution were added, and heating, when the whole dissolved easily, giving a green solution, which, on boiling, in no case deposited the least trace of cuprous oxide, whereas, after adding an excess of hydrochloric acid to the liquid, boiling, filtering off the insoluble products, again making alkaline and boiling, the glucose reaction took place in a marked manner.

This experiment has never in any case failed, and it would follow, if uniformly successful, that the green leaves of all plants contain a glucoside insoluble in water, but soluble in alcohol and ether. That this glucoside is, in fact, chlorophyl seems to me highly probable.

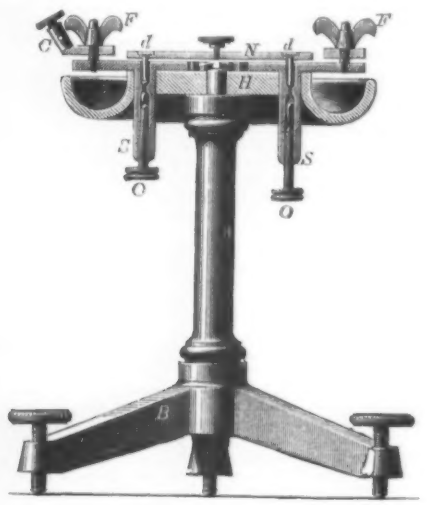
Nevertheless, absolute certainty cannot be attained, because the matter experimented on is a mixture, and it is possible that one plant out of many might give a decidedly negative result, which would upset the conclusion drawn from the rest.

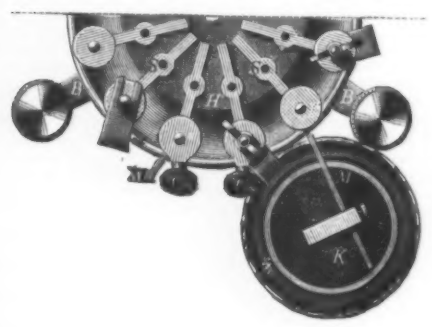
Assuming, however, that the phenomena will always occur as above described, and that the reaction with Fehling's solution indicates the presence of some kind of glucose, it would follow either that chlorophyl is a glucoside, or that it is always accompanied in the vegetable cell by a glucoside of very similar properties.

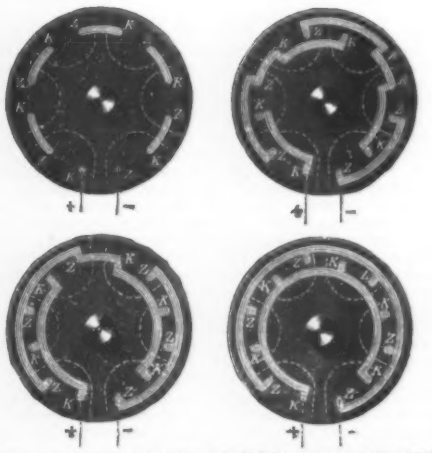
I may add that I attempted to isolate the glucose or glucose-like substance formed under the circumstances described, spinach leaves being the material employed, and obtained a pale yellow gum-like substance which showed no tendency to assume a crystalline form.

DR. MATTHIESSEN'S BATTERY COUPLER.

OUR engraving represents a commutating apparatus, by means of which any number of batteries may be joined in







FIGS. 1 AND 2.—DR. MATTHIESSEN'S BATTERY COUPLER.

series, in parallel circuit, or in any desired combination. The apparatus designed by Dr. L. Matthiessen possess the advantage that changes can be effected in very short time and without breaking the connection between individual cells.

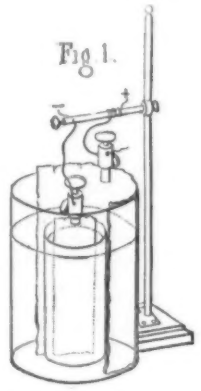
Fig. 1 shows a sectional side elevation together with a half plan. It consists of a tripod, B, provided with leveling screws, carrying a standard, A, to the top of which a plate of ebonite, H, is screwed. Into this plate twelve mercury troughs are inserted, the tops of which are extended into flat disks. Six of these troughs are connected with the zincs, and the remaining six with the carbons by means of the movable arms, M. Besides this, two of the troughs carry binding posts, CC, to which the wires of the external circuit are attached.

The commutator disks, the platinized pins of which fit into the mercury troughs, are shown in Fig. 2. The removal of one disk and replacing of another is all that is required to effect any desired combination. The advantage derived from the use of the mercury troughs as shown, consists in the fact that the height of the mercury can be regulated by the screw, O, in such a manner as to barely touch the pin, *d*, thus preventing the spurting about of mercury when changing disks; and furthermore, when out of use or when being moved about, the lowering of the screws, O, allows the mercury to fall low down into the trough, where it is secure against spilling and consequent loss. Finally the mercury can be entirely and safely removed by unscrewing O entirely. The ebonite plate, H, is surrounded by a ring-shaped trough to retain any mercury which may be accidentally spilled while filling the troughs.—*Ztsch. f. Instrumentenkunde.*

FORMATION OF COLORING MATTERS BY ELECTROLYSIS.

As long ago as 1875, Mr. Goppelsroeder announced to the Industrial Society of Mulhouse that, while studying the action of the galvanic current upon organic bodies (and principally those of the aromatic series), he had observed a large number of electrolytic reactions of these bodies that demonstrated the fact that, through the electrolysis of benzol, coloring matters form either at the positive or negative pole. He was persuaded that, by the use of a cheap generator of electricity, coloring matters might be cheaply manufactured by means of different bodies of the aromatic series.

Fig 1.

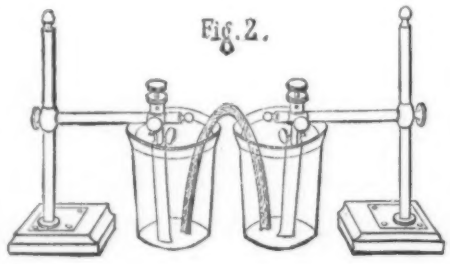


Messrs. Girard & Laire have devised a process by means of which aniline blue is prepared without the use (as was formerly the case) of rosaniline. In this process the product employed is diphenylamine, which is prepared by the reaction of aniline upon its hydrochlorate. In order to convert diphenylamine into blue, it is mixed with sesquichloride of carbon, and kept at a temperature of from 160° to 180° for three or four hours.

To cite but this example, Mr. Goppelsroeder obtains the same blue by a simpler and cheaper means, and that is through the electrolysis of a solution of diphenylamine. The blue is then obtained at the positive pole.

In order to produce the current, he employs either a 16-couple bichromate of potash and sulphuric acid pile, or a Bunsen one. To prevent as much as possible the influence of one pole upon the effect of the other, he employs porous clay cylinders (such as are used in the Bunsen pile) filled with that part of the liquid which is not to furnish the principal electrolytic product, and into which is immersed the secondary electrode (Fig. 1); or else he divides the electrolytic liquid between two vessels, and leads the galvanic current from one to the other by means of Swedish filtering-paper. He also employs as a constructing medium a band of cotton wicks (Fig. 2) covered with parchment paper from

Fig. 2.



the surface of the liquid, so as to prevent the drying up of the conducting fluid. In the same way, he has used asbestos paper or card board, various textile fibers, U-shaped tubes filled with the electrolytic fluid, etc. If necessary, he increases the conductivity of the solutions by the addition of a little sulphuric or hydrochloric acid. The conducting fibers become more or less dyed during the operation—unequally and imperfectly, and principally in that portion that is situated on the side of the pole where the coloring forms. This is a fact to be noted.

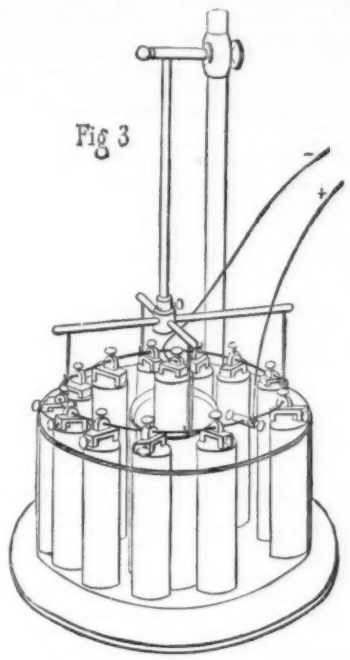
For electrodes, Mr. Goppelsroeder has used platinum or carbon, such as is employed for piles. In many cases he has had recourse to rounded carbons so arranged (Fig. 3) that the cylinder whence hydrogen is disengaged shall be in the center of a porous cylinder, while the others, whence oxygen is disengaged, are arranged around it. In this way the action of the current is stronger. Mr. Goppelsroeder has also inclosed the positive electrode in a cotton bag, and has found that in this case the precipitate does not attach itself so firmly to the platinum, and deposits between the latter and the bag. In certain cases he has employed lead, the plate of which was then wound spirally around a clay cylinder in which there was a piece of lead as a negative pole. After the operation the leaden plate was straightened out, and the precipitate detached from it by means of a brush and some water (Fig. 4)

The principal electrolyte for these metamorphoses, that is to say, the important substance that is to be decomposed by the galvanic current, is water. The oxygen that proceeds therefrom, either in its nascent state or in the form of ozone, acts upon the bodies, which through dishydrogenation or oxidation, are to be changed into coloring matters. In this way, the salts of aniline, toluidine, diphenylamine, methylaniline, methyldiphenylamine, and phenol and the salts of naphthylamine are changed into coloring matters.

Thus, in the formation of aniline blue by Messrs. Girard & Laire's process, the sesquichloride of carbon causes a dishydrogenation of the diphenylamine. In Mr. Goppelsroeder's electrolytic process, oxygen in a nascent state performs such office in connection with a solution of sulphate of diphenylamine.

The hydrogen that is given off from the negative pole also causes some changes; with naphthylamine a curious thing

Fig 3

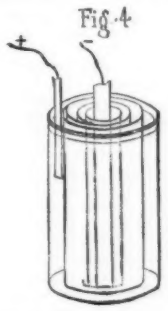


occurs, for at the positive pole there is a formation of brown alongside of violet and other coloring matters, while at the negative there is a formation of very pure violet.

In order to show that the oxidizing or dishydrogenizing action is more complicated than might be supposed, we shall recall the interesting fact discovered by Mr. Berthelot: If sulphuric acid be added to the aqueous solution in order to render the liquid a better conductor, the acid becomes changed into persulphuric acid.

As well known, in order to obtain the different colors derived from aniline, we are obliged to have recourse to chemical operations that are quite complex.

Fig 4



By means of simple electrolytic operations Mr. Goppelsroeder has obtained many coloring matters, among which we shall merely cite the following:

Aniline black, obtained from the electrolysis of hydrochlorate of aniline.

Pure rose, obtained from a solution of hydrochlorate of aniline with the addition of aniline and ammonia.

Very *pure violet*, by the electrolysis of the same solution.

Blue, obtained by the electrolysis of a solution of diphenylamine.—*Le Genie Civil.*

POPULAR FALLACIES IN REGARD TO VENTILATION.

By CHARLES R. DRYER, M.D., Prof. of Chemistry and Toxicology, Fort Wayne College of Medicine.

THE importance of educating the people as to the care and preservation of health and the rearing of children can hardly be overestimated. The work of such education devolves largely upon the physician. The neglect of this duty, though common, is not on that account more pardonable. It may be of use to call the attention of the profession to a few important points.

The first and great popular fallacy in regard to ventilation is that it needs no special attention.—This is a more serious error among the well-to-do than among the poorer classes, inasmuch as the houses of the former are more nearly air tight. With solid brick walls, double sashed windows, weather-stripped doors, and a base burning coal stove, the exclusion of pure air is carried to the utmost extent. This condition is happily somewhat relieved by the use of open coal grates. But how many fine houses does the physician enter without noticing the close, foul odor and the stifling air which come from over heating and poor ventilation? In such rooms he finds nervous, headachy women, and pale, irritable children suffering from colds the winter through. Such families need judicious instruction that respired air contains one of the most virulent poisons known, and that dry and overheated air is debilitating and irritating, leaving the mucous membranes sensitive to be inflamed by every breath of the natural atmospere.

The second popular fallacy is that the poison of respired air is carbonic acid.—This is an example of superstition, or the "survival" in science of an idea long after it has been proved to be false. It is perpetuated in school text-books and popular treatises innumerable. Indeed, correctness of statement upon the subject is the rare exception, gross error the rule. Carbonic acid gas is no more poisonous than water; animals immersed in it die just as they do if immersed in water, and for the same reason, viz., want of oxygen. Birds have been made to live in an atmosphere containing 35-40 per cent. of pure carbonic acid and about an equal per cent. of oxygen. Yet when the carbonic acid of *respired air* rises to one per cent., that air is a very dangerous poison.

The solution of this puzzle is that respired air contains a very small proportion of poisonous organic matter, which is constantly exhaled from even the healthiest lungs. Its exact nature has not been determined. It is the source of the foul odor so characteristic of badly ventilated rooms. The air from the exit of pipes of a crowded hall darkens sulphuric acid, decolorizes potassium permanganate, and causes water or a sponge saturated with it to putrefy. This poisonous matter is produced in quantities proportionate to the amount of carbonic acid, hence the quantity of the latter is an indicator of the relative quantity of the power; and carbonic acid should never be allowed to accumulate in occupied rooms to the extent of seven-tenths of one per cent.

The third popular fallacy is that the most impure air accumulates near the floor of the room.—This false idea has probably arisen from the fact that carbonic acid is more than half as heavy again as air, and can be poured from one dish to another like water. Although this is true when both gases are at the same temperature, a very little difference of temperature is sufficient to reverse these conditions. Respired air issues from the nostrils at a temperature of nearly 100° F., and is lighter than the outer air at 70° or at 80°. Again, the temperature of the body is nearly 100°, usually much above that of the surrounding air. This is sufficient to create an upward current rising from the body of every person in the room, just as the heated air rises above a hot stove. If to these influences be added the more powerful action of a stove, register, or other heating apparatus, it will be understood how the impure air rises and accumulates very rapidly near the ceiling. This can be easily proved by experiment, such as placing candles at various heights.—The upper one will burn much more dimly than the lower. At the same time the cooler air on the floor moves toward the stove to enter it or to join the current rising from it.

The fourth popular fallacy is that the outlet for impure air is best placed at the top of the room and the inlet for pure air at the bottom. This may seem a contradiction to the third fallacy, but is not for several reasons. An opening into a cold place at the top of the room is often not an outlet at all, but simply allows cold air to drop down into the room. If it be an outlet, it is very wasteful of heat. The air of the room is heated at some expense and then turned out of doors as soon as possible. If the inlet be near the floor, there will be a cold draught upon the feet of the occupants of the room, and although such an arrangement may ventilate, it will be attended with such disadvantages as to render it highly objectionable. Wherever possible, there should be an outlet near the floor into a heated flue, in which the upward draught is sufficient to constantly draw the cooler air off the floor. An open fire flue is the most efficient outlet that can be devised. Instead of that, a direct draught stove in which a door above the fire may be opened answers the purpose admirably. The inlet may be for pure heated air through a register near the floor on the opposite side of the room from the outlet, or for pure cold air by an opening directed upward behind the stove and above the heads of the occupants of the room. Thus all cold draughts will be avoided, the pure cold air will mingle immediately with the impure air near the ceiling, and the room will be equably and economically warmed, and efficiently ventilated. June air may be had in January, and the children will be as merry and rosy as the street children, who have nothing but oxygen to make them merry.—*Fort Wayne Jour. Med. Sci.*

FATTY DEGENERATION OF THE HEART—ITS DIAGNOSIS AND TREATMENT.

By CHARLES R. CRANDALL, M.D., Portland, Me.

CASE I. John B., aged fifty-four, a farmer by occupation and of temperate habits, had always enjoyed good average health up to two years before coming under observation, when he had an attack of idiopathic erysipelas, which lasted for several weeks. His recovery was slow and imperfect, and he felt that his general health had been much impaired. Three months previous to my seeing him he had what was called a "slow fever," and from this his recovery was also tedious. After these attacks he never knew what it was to be well, and he suffered more or less from the following symptoms:

He had headache much of the time and occasionally attacks of vertigo; his breath was short, and would seem to fail upon the slightest exertion or excitement; he had a constant sense of failure about his heart, and at times vague and irregular pains; he complained, besides, that he had palpitation and a sense of fluttering in the region of his heart.

He was also a great sufferer from acidity, vomited occasionally, and had a badly coated tongue. These later symptoms, accompanied by constipation, led him to believe that he was "bilious" all the time, and induced him to make frequent use of purgatives. The general surface of the skin had a shriveled look, as if nutrition and circulation were both defective. The veins about the forehead were prominent, while those of the lips were also full, giving a cyanosed appearance to those surfaces. There was a well defined *arcus senilis* upon the cornea of either eye.

The action of the heart was slow, as indicated by a pulse of sixty, and the first sound was feeble, while the second was well marked. There were, however, no valvular murmurs or lesions of any description. Upon percussion, it was found that the size of the heart was rather above normal, which I attributed to either the hard work he had done in the past or else an accumulation of fat.

The percussion note at the base of both lungs was slightly dull, which I explained on the theory of venous stasis due to impaired circulation. There were some moist rales in the larger bronchial tubes, but beyond this the lungs were in fair condition. The kidneys were normal, and the quantity of urine approximately about what should be expected. There had never been evidences of dropsy in any portion of the body.

The general condition of the patient was that of feebleness and general decline. He returned to his country home, and the termination of his case is not yet known.

Case II. Mrs. L., a married woman aged sixty-seven, having a family grown, was large of stature, rather corpulent, and of a good history of general health up to within a few years. I was called to see her early one morning, and found that she had had several attacks of vomiting during the night, chilly sensations, more or less cough, profuse expectoration of frothy mucus, and a sense of fullness and pressure under the sternum and in the right lung. Her breathing had been rapid and difficult, and there had been a sensation in the region of the heart which she characterized as "a strange feeling" and "a weakness." I noted that her cheeks were somewhat flushed and that her lips were decidedly blue. Looking into her eyes, I detected a well defined *arcus senilis* in the cornea of each eye. Her pulse was feeble and running at the rate of about sixty-five a minute. The extremities were cool, and the flesh yielded a decided sense of flabbiness to the touch.

On auscultation of the heart, I heard a soft, feeble first sound and a fairly marked second sound. There were no cardiac murmurs or other evidences of valvular lesions. Mucous rales were abundant in the lower portion of the right lung, while the left seemed to be in a nearly normal condition. The percussion note at the base of the right lung was somewhat diminished. The temperature was normal, and there were no symptoms of inflammatory action.

I treated her for congestion of the lungs due to heart failure, and she recovered to a considerable extent in three or four days. Her convalescence, however, was slow, and she suffered much from general debility and shortness of breath. At times her breathing would be very feeble and irregular, and at other times would almost stop, and then become quite strong again. She complained a great deal of strange sensations in the region of the heart. At times there would be over-action, and again the sensation would be that of failure, as if the organ was about to stop. Moreover, she complained of coldness of her limbs, "creepy sensations" down her back, and of "tingling and numbness" in her left arm. One day she told me very confidently that at three different times during the last two years she had had "strange spells," which made her believe she was losing her mind. Each "spell" had occurred when she was out walking and had become rather tired. Upon each occasion her vision became dim, her mind confused, her breath short, and her limbs weak, and she would try to get somewhere to avert what seemed to her was impending death. So soon as she could sit down and get rested this alarming condition would pass away, and she would find herself panting for breath and her heart palpitating rapidly.

Under continuous treatment this patient has steadily improved, and has had a year of very satisfactory health.

My diagnosis in each of these cases was fatty degeneration of the heart, and it was based upon the signs and symptoms present as well as upon the general laws of the disease. But, before going into the symptomatology of this disease, let us note the meaning of fatty degeneration. As the term implies, the structure of the heart degenerates, and in time certain portions are transformed into an oily or fatty material. The initial point of degeneration is along the longitudinal fibers and within the substance of the muscle. At first the deposits of fat are microscopic in size, and appear as globules of oil or fat distributed along the fibers of the muscle. "It is usually most noticeable in the inner layers of the myocardium, which are particularly prone to fatty degeneration." With the advance of the disease the globules of fat increase in size, followed by a dimunition and degeneration of the true muscular structure. In the early stages the deposits of fat may be more or less localized, but in advanced stages of the disease the entire organ may be involved. With increase of the fat the color of the organ undergoes change. Excess of fat in spots may give it a sort of mottled appearance. In advanced cases, where there is general involvement, there may be a paleness about the organ, or a "yellowish-brown, or buff, or muddy-pink color." When degeneration has gone on sufficiently far, the consistence of the organ is markedly changed; it becomes soft and yielding, and, in advanced cases, the tissue is so utterly destroyed that it will break or mash down under pressure. Such are some of the gross lesions found in a well marked case of fatty degeneration of the heart.

Returning now to a consideration of the causes and symptoms of the disease, I will say that in both of my cases the age of the patient was sufficiently great to assign it as a predisposing cause. Fatty degeneration of the heart is most common between the ages of fifty and seventy. Watson teaches that it is most common at about the sixty-third year. Of eighty-eight cases collected and analyzed by Hayden, the larger number were between the ages of sixty and seventy.

Obesity is considered to be another predisposing cause. While it is not a cause upon which much stress can be laid, nevertheless, as my female patient was corpulent and flabby, I accepted that condition as a predisposition to the disease from which I believed she was suffering. Thus both patients had predisposing conditions which would naturally form powerful factors in diagnosticating fatty degeneration. Both had indistinct first heart sounds, accompanied by a generally weak and irregular condition of the entire organ. Nearly all authorities lay much stress upon these physical signs when accompanied by the other general symptoms of fatty degeneration.

In regard to this point Da Costa has said: "We may, however, suspect it [fatty degeneration] if the signs of weak action of the heart—feeble impulse and ill-defined sounds—coexist with a pulse permanently slow or permanently frequent and irregular, and be met with in a person who is the subject of a wasting disease, or who has arrived at a time of life at which all the organs are prone to undergo decay. Something more than a suspicion is warranted if, in addition, there be proof of fatty degeneration elsewhere, such as an *arcus senilis*.

An important symptom at times in both cases was irregular, rapid, and difficult breathing, which we attributed to heart failure. This symptom would naturally enough be present with a feeble heart, because the circulation through the lungs must necessarily be slow, rendering the condition most favorable to venous stasis. In case second the irregular breathing was at times of the peculiar kind known as "Cheyne-Stokes dyspnœa," or "the ascending and descending respiration." So common is this form of dyspnœa in fatty degeneration of the heart that it was for a long time considered characteristic of the disease; but at present it is only admitted as corroborative evidence when found associated with other well marked symptoms. As before intimated, the second patient had at times a tendency to syncope, which is a condition more or less associated with a fatty heart. The remarks of two eminent authorities on this symptom are especially worthy of citation, for they tend to explain in some degree why it is that elderly people often have "fainting spells," or have attacks which they dread as being precursors of apoplexy. Da Costa says that these patients may be "subject to seizures during which their respiration seems to come to a standstill; and that they are liable to be stricken down with repeated attacks having the character of apoplexy, save that they are not followed by paralysis." And Flint directs our attention to the fact by observing that "these patients are liable to seizures resembling apoplexy, characterized by temporary loss of consciousness, without paralysis, the surface being pallid and cool and the circulation feeble."

Both patients had well marked *arcus senilis*. The presence of the senile arc is not given the diagnostic importance it formerly was, but, when found in elderly persons in connection with the other symptoms herein referred to, it is worthy of consideration. It usually points to degenerative changes, but modern investigation has overthrown the view that it has a pathognomonic relation to fatty degeneration of the heart. It is now believed that it may occur either with or without the degeneration of the heart.

Again, both patients suffered from indigestion and what they characterized as "biliousness." This is another common symptom belonging to the group of those having a diagnostic importance. It is believed to be due to impaired circulation resulting in secondary congestion of the stomach and liver. After this state exists for a time it causes a catarrhal condition of the mucous surfaces of the organs of digestion, and there result acidity, pyrosis, flatulence, and other well marked symptoms of indigestion.

Lastly, both patients complained of pain and other strange sensations occurring in the region of the heart. In many of the cases of fatty degeneration of the heart, patients will complain of a "peculiar feeling," of "some pain and fluttering," of "a queer feeling," of "a sense of weakness or failure," or "a sense of suffocation." Others will add also that they have a sense of fullness under the sternum, pain and numbness in the arms, and "cold and creepy feelings" down their backs. These symptoms are often encountered in elderly people, and they should always be taken as suggestive of dangerous disturbance in the heart and circulation. While it may be said that there are no one or two symptoms that are pathognomonic of a fatty heart, when one comes upon a group like the foregoing occurring in an old person, there seems but little room left for doubt.

But few words are required regarding the prognosis. In one sense it is always unfavorable, while in another it is often made favorable by regulated habits and medical treatment, which aid greatly in prolonging life. But the rule is, that, as years increase, patients thus afflicted become feeble and steadily fail. At times they sink from intercurrent disease or wear out from difficult breathing, dropsy, and debility. Again, they die suddenly from cardiac syncope or else from rupture of the heart.

"Of eighty-three cases of fatty disease of the heart, collected by Quain, sixty-eight died suddenly."

The treatment indicated is worthy of consideration, for, if well carried out, a valuable life may be decidedly prolonged.

1. Treatment should be supporting. Everything should be done to preserve muscular integrity and maintain vitality. Proper exercise, good food, fresh air, plenty of sleep, tonics and stimulants, make up the daily requirements.

2. Moderation in all things is a law that must be enforced. The penalty of its violation is rapid decline, constant distress, perhaps sudden death. Whatever exertion taxes the strength, causes mental excitement, or wearies the nervous system may cause failure or a rupture of the cardiac walls.

3. These patients must not be housed up, for they need the vitalizing effects of pure air, sunshine, and gentle exercise. These can be best obtained by short, easy walks and daily rides in an easy carriage. When seeking out of door life, exposure to cold and damp or excessive heat must be guarded against, for whatever disturbs the circulation, or prostrates, will imperil the diseased heart.

4. The diet should be nutritious and easily digested. Of the articles most appropriate may be mentioned skimmed milk, tender fresh meats, fruits, Graham or gluten bread. These are wholesome blood and muscle making foods, and have no special tendency to make fat.

5. Stimulants under such conditions are to be given judiciously, but nearly all these patients need them more or less. General debility and a feeble heart make a permanent demand for a mild stimulant which will help promote digestion and sustain the vital powers. In case second I found that a small quantity of sherry wine taken four times daily seemed of the highest utility in maintaining the force and regularity of the heart's action.

6. In regard to general indications for treatment, there is much to be looked after, for these patients generally suffer from shortness of breath, poor appetite, indigestion, anæmia, attacks of syncope, and headache. Hence there is the constant demand for strychnine, digitalis, caffeine, opium, iron, and quinine. These, together with wine and a regulated diet, will do much toward prolonging life.—*N. Y. Med. Journal.*

MALADY FROM VANILLA.

THE interesting investigations made by Dr. Layet, of Bordeaux, are thought to satisfactorily explain the nature of certain injurious properties of vanilla. The affections have been studied at a warehouse in Bordeaux, where on an average 25,000 to 30,000 kilogrammes of vanilla arrive every year. In these storehouses the pods are cleansed, and sorted according to quality—manipulations which seem to cause certain symptoms among the operatives. At first an itching of the face and hands associated with a powerful smarting sensation is experienced, and the skin becomes covered by a pruriginous eruption, swells, reddens, and desquamates at the end of some days; at other times there is a feeling of malaise with dullness, stiffness, and muscular pains, necessitating a cessation of labor. The cutaneous malady seems to be due to an acarus which appears as a small, white, rounded body, occupying generally the ends of the pod, and determines the affection by its mere contact. The nervous symptoms, M. Layet thinks, may be caused by inferior pods containing much oily juice.

To prevent the cracking of the glass tubes that are connected with steam-boilers to show the height of the water within, and which is of a more or less frequent occurrence, as the tube is of a high temperature inside and a cold current can strike them from the outside, the *Industrie Blaetter* recommends the use of two glass tubes, one within the other. The air that is confined between the two serves as a protection to the inner tube against outside cold, and the outer one against the high temperature of the inner one. Both tubes are packed in brass couplings, and form one single instrument.

MANGANESE STEEL.*

By JOSEPH D. WEEKS.

MANGANESE has, until recently, been most highly esteemed as a good thing to keep out of steel. Its value in the process of manufacture has been fully recognized; but after it has played its part in the crucible or the converter, then the less of it the better. It is true that the mission of this metal and its influence upon the character of the steel have been a source of much controversy. Our own Holley, in one of his special reports on ferro-manganese, states: "It has been suspected by some and believed by a few, while it is still denied by many, that manganese as an ingredient in steel has not only a body-giving and toughening influence, but a positive neutralizing influence upon any excess of hardening or cold shortening substances, as phosphorus." In another paper on the same subject, he states: "It should appear from such facts as we have that manganese toughens the structural steels, increases their soundness, and prevents red-shortness." Notwithstanding these rather guarded assertions as to it value, the general belief, it will be found, is with Dr. Siemens, that manganese is "merely a cloak to hide impurities," and its presence in steel has been endured, not welcomed.

But whatever may have been the difference in opinion as to the effect upon steel of a small percentage of manganese, not to exceed say 1½ per cent., there has been a general agreement among metallurgists that any amount in excess of this would produce a metal rotten and utterly worthless. In the Terre Noire experiments referred to in Mr. Holley's report before quoted, 1 per cent. is the highest given as found in the steels reported upon. In a paper read by M. Gautier, of Terre Noire, before the British Iron and Steel Institute on the "Uses of Ferro-Manganese," this same percentage is given as the proper amount to be used in the manufacture of what this distinguished metallurgist terms "manganese steels," while in all three of the papers the analyses of the steel show the usual percentage of the manganese to be much below this. Indeed, from 1 per cent. to 1½ per cent. has been regarded universally as "high manganese," and the published testimony is, that more than this renders steel worthless.

In opposition to these views, Mr. Robert Hadfield, of the Hadfield Steel Foundry Company, Sheffield, England, has demonstrated that a steel containing from 7 per cent. to 30 per cent. of manganese is not only not a rotten and worthless product, but that in the ingot, as cast, it is harder, stronger, denser, and tougher than most steel now manufactured, even when forged and rolled, and in addition it possesses curious and remarkable properties, which, it is believed, will make this steel exceedingly valuable for many purposes for which the ordinary steels are not now used.

In the sample of steel which, through the kindness of Mr. Hadfield, I am permitted to exhibit to the Institute, the manganese is from 9 per cent. in ingot No. 10 to 19 per cent. in the ax. No samples of the higher percentage have reached me. The bent flat piece contains 9½ per cent.; ingot No. 180 and the pit car-wheel that has been so badly hammered with so little effect, 11½ per cent.; the adz, 13¾ per cent.; and ingots Nos. 20 and 21, 14½ per cent. The ax and adz are castings just as they came from the sand, neither forged nor hardened, and have been ground since I received them. These are rough specimens, the Hadfield foundry not being adapted to this class of work; but with proper care in moulding and manufacture, such articles can be made as smooth and clean as cast iron. Indeed, some of the most valuable characteristics of this steel are shown in casting. It possesses great thinness and fluidity, casts without misrunning, does not settle as much as ordinary castings, and does not draw, particularly at the junction of the thick and thin parts. It is also free from honeycomb and other similar defects.

It is evident that a metal that casts in this manner and that needs no hardening or tempering must be especially adapted not only to the manufacture of most articles that are now cast, but for a wide range of articles that are now forged, rolled, or hammered; such as the larger edged tools, hammers, picks, etc., guns, armor plate, shell and other projectiles, car-wheels in place of chilled wheels, implements, and parts of machinery, especially bearing parts, safes, steel toys, plow steel, etc. A razor has been cast from this steel, and used without hardening. It was not equal to the best steel razor, but it was a fair implement.

But perhaps the most remarkable and valuable of the properties of Hadfield's steel is it great toughness combined with its extreme hardness, two properties that are generally regarded as incompatible. The toughness will be evident upon an inspection of the fracture of the ingots. The little steel needles scattered all over the face of the fracture, forming an acute angle with the face, show the character of the rupture to be entirely different from that of ordinary steel. These needles are very tough, and, small as they are, do not break off when struck, but bend almost like native copper. It also requires a blow of considerable force to bend them. It was exceedingly difficult to break these ingots, a number of blows of a steam-hammer being required, sledges having no effect. Ingot No. 10, with 9 per cent. of manganese, was broken from a piece 2 feet 6 inches long, supported at both ends. It bent 1½ inches before breaking, though it had not been forged. Hammered samples from this ingot gave 42 tons (94,080) tensile strength and 20·85 per cent. elongation in 8 inches. The flat piece No. 180 (9½ per cent.) that has been hammered was bent cold, and does not show the least crack. This piece has been drilled. The bulging of the steel under the drill point is quite noticeable. This piece of wire was also bent cold after drawing. The small colliery wheel (11½ per cent.) was struck fifty blows with a heavy sledge, and bent as will be seen.

Notwithstanding this toughness, the steel is extremely hard. The lower percentages, say from 9 per cent. to 10 per cent., which are the toughest, can be drilled and machined, but not as readily as the ordinary steels; those somewhat higher, with difficulty; while it is practically impossible to drill, turn, or otherwise machine the higher percentages. The colliery wheel that bent so under the sledge blows shows on the tread and hub the results of attempts made in this country at my request to drill and turn them. The edges were taken off the tools instantly, hardly scratching the wheel. The ax (19 per cent.) and the adz (13¾ per cent.), as has been already stated, were sent me rough as they came from the sand, and were ground by Messrs. Hubbard, Bakewell & Co., Pittsburg. Regarding the steel, Mr. Charles W. Hubbard writes me:

"The steel ax and adz we ground for you were extremely hard. There seems to be a peculiarly close, hard, greasy nature about the material that resists the action of the grindstone and emery wheel, as they have less effect on them than anything we have ever seen in the line of steel or iron. I would say the material has the very essence of anti-friction. A journal made of such material would run to an extreme number of revolutions in a sand-box without friction or heat." I have not tested this ax, but one made in a similar way cut through ¾ inch iron.

I have already intimated that this steel can be rolled and forged. The lower percentages are more easily worked, but steel with as much as 18 per cent. has been hammered. The higher percentages require great care, however. One of the most remarkable properties of this steel exhibits itself in connection with hammering or drawing it. When thus manipulated, it becomes exceeding hard, and loses some of its toughness. If now the steel is heated to a hot heat, yellow or nearly welding, and allowed to cool in the air, or is cooled in water or oil, it becomes exceedingly tough. The flat piece No. 140 was so heated and cooled before being bent. The wire was similarly treated after drawing, which made it extremely hard. This is virtually annealing, but it will be noticed that it has the effect upon Hadfield's opposite to that upon carbon steel.

It should be noted that this steel is non-magnetic in bulk, and a poor conductor, though fine drillings and scrapings are attracted by the magnet.

The process of manufacturing this steel is exceedingly simple. Melted ferro-manganese high in manganese (Mr. Hadfield suggests 80 per cent.) and as low as possible in carbon, silicon, and other foreign bodies, is added to iron that has been nearly or quite decarburized, or to molten steel. The manganese is thoroughly incorporated by stirring, and the steel poured into ingots or other suitable moulds. The percentage of ferro to be used, and consequently the amount of manganese in the steel, must be varied according to the use to which it is to be put. No absolutely exact proportions can be given. To produce a steel suitable for armor plates, sufficient ferro to give say 10 per cent. manganese in the steel should be added; for car wheels, axles, or railroad plant, say 11 per cent.; edge tools and steel toys, 12 per cent.

* Read at the Chicago meeting of the American Institute of Mining Engineers, May, 1884.

A NEW TRANSLATION OF THE LAST WORDS OF JESUS OF NAZARETH.

THE Maya language seems to have been known by some of the learned men in Judea even at the beginning of the Christian era. The last words of Jesus of Nazareth when dying on the cross were undoubtedly spoken in that language. His biographers, Matthew and Mark, tell us that, a few moments before expiring, he exclaimed with a loud voice, "*Eli, Eli, lama sabachthani;*"* and hat those who stood near him believed he was calling Elias to his rescue.

These words have been wrongly interpreted by the translators of the New Testament. Rendering them "*My God, my God, why hast thou forsaken me?*" they have done a great injustice to the character of Jesus, presenting him in his last moments despairing and cowardly, traits so foreign to his life, to his teachings; so contrary to the resignation shown by him during his trial; to the fortitude he gave proof of in his last journey to Calvary. By placing in his mouth such exclamation they make him represent to the face of mankind a sorry and pitiful role, I will not say for a god, but for a man even. Besides, at the time that they proclaim him to be a god, the Ruling Spirit of the universe, they offer the strongest argument against his divinity. If he is GOD, why complain that GOD has forsaken him? This is illogical, a nonsense that places us in this dilemma: Either to deny that he ever uttered such exclamation as that transmitted to us by the writers and translators of his biographies, and therefore gainsay the veracity and inspiration of the Gospels, or that if he gave vent to his feelings in these words, he complained to a being he knew superior to and more powerful than himself. If then we admit he was a god, he was an inferior one, and we have forced back upon us the doctrine of the plurality of gods.

Again, in order to ascribe to the words

אֵלִי אֵלִי לָמָה שְׁבַקְתָּנִי

(*Eli, Eli, lama sabachthani*) the meaning given them by the translators, it would be necessary to suppose that the dying martyr became out of his mind at the point of death, lost his memory, and that, being unable to give vent to his despair in one language, he had to make use of words belonging to two distinct tongues—the Chaldee and the Hebrew—since the last word שְׁבַקְתָּנִי—*hast thou forsaken me*) is Chaldaic, and the others are Hebrew. That he spoke in a dialect not understood by those who surrounded him is evident. His biographers, Matthew and Mark, assert that several, under the impression that he complained of being thirsty, went and brought a sponge saturated with vinegar;† others believed he was calling Elias ‡

His bosom friend and cousin, John, who never abandoned him, who stood to the last at the foot of the cross, with his mother and other friends and relatives, does not report such unbefitting words as having been uttered by Jesus. He simply states that, after recommending his mother to his care, he complained of being thirsty, and that as a sponge saturated with vinager was being applied to his mouth he merely said: "IT IS FINISHED!" and bowed his head and gave up the ghost.§

It is finished! expresses exactly the meaning of the Maya words: *Hele-Hele-lamah zabac-ta ni,*‖ which translated literally say, *Hele*, now; *Hele*, now; *lamah*, sinking or fainting; *zabac*, soot or anything black; *ta*, over; *ni*, nose; freely, *Now! now! I am fainting; darkness covers my face.* No weakness, no despair; he merely tells his friends all is over—*it is finished*—and expires.

AUGUSTUS LE PLONGEON, M.D.

* Matthew, chapter xxvii., verse 46. Mark, chapter xv., verse 34.

† Matthew, chapter xxvii., verses 47, 48. Mark, chapter xv., verse 36.

‡ Mark, chapter xv., verse 35.

§ St. John, chap. xix., verse 30.

‖ Juan Pio Peres, Maya Dictionary. This work is for sale at the drug shop of Mr. George Shield, 806 Broadway, N. Y. Fray Pedro Beltran—Art and Vocabulary of the Maya Language.

My attention was first called to these words of Jesus, with relation to the Maya language, by my friend the Bishop of Lero, Don Crecencio Carillo y Ancona, of Merida, Yucatan, a scholar in the Maya language, a well-known student of archæology and ancient history of his country, a writer of no mean attainments, who has published various works on those subjects.

THE SENSE OF TOUCH.

THE system of exact measurements and close work now being generally adopted in machine shops necessitates a higher education of at least one of the senses, that of touch. It has always been the fact that calipering could be better done by feeling than by seeing, and any departure from truth in diametrical circularity can be determined by the sense of feeling when the sight is of no avail to detect the fault. There is one peculiar test that is sometimes used as a gratification of curiosity—that of passing a piece of turned and finished round iron between the teeth while slowly revolving it between the fingers. No matter how small the departure from truth, it will be detected by the sensation of feeling transmitted from the teeth. The folly of file finishing in the lathe is shown by this test. It is not possible to preserve the circularity of the surface of turned work when the turning is finished by the file. The only abrasive means to finish turned work is the swiftly revolving grinding wheel of emery or corundum. Hand filing in the lathe is a delusion.

Recent experiments to determine the reach of the sense of touch for measurements seem to decide that mechanics with educated sense can determine a variation of one twenty-thousandth of an inch. But there are men of exceptionally sensitive touch who can determine differences which are less than one thirty-thousandth of an inch. The fact of these determinations was demonstrated by means of readings on a scaled rule, through a microscope. Fits and finishes of one ten-thousandth of an inch are as near as general utility demands; the more exactive measurements of one fifty-thousandth of an inch being useful mainly as standards.

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